SCIENCE FOR HAIRDRESSING STUDENTS

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FOREWORD

THIS book is intended to cover the revised syllabus in Science for the Craft Course (263) in Hairdressing of the City and Guilds of London Institute. It is designed particularly for the young apprentice who has had no previous training in Science.

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I
DIRT AND CLEANLINESS

It is important that the hairdressing salon and everything in it should be clean. However clean it is to begin with each morning, dirt is constantly entering it during the day through windows and on the clothes and feet of staff and customers. Refuse and rubbish also collect in the salon all day.

There is nothing magic or unnatural about dirt. It is simply matter which appears in places, and occurs in forms, inconvenient or dangerous to man. Some of it, garden soil, for instance, is valuable material in some places and a nuisance in others. Much of it is dangerous because it provides breeding grounds and hiding places for organisms which cause disease.

If dirt and rubbish were not systematically removed but allowed to collect, the salon would become grimy, untidy and uninviting and it would become a menace to the health of staff and customers.

THE NATURE OF DIRT

Dirt in the salon will consist of dust, grease and waste rubbish. *Dust* is made up of very fine particles of material and its composition will be slightly different in different neighbourhoods, according to the surroundings and the work carried on in the area. In most districts it will probably contain varying amounts of these things:

fine grit from soil, roads and factories
particles of tar and ash
soot from fires and carbon particles from car exhausts
particles of dead vegetable matter
spores of fungi
bacteria and bacterial spores
pollen
minute specks of dried manure, vomit, pus and phlegm
particles of hair from humans and animals
particles of feathers
particles of dead skin
fluff and fibres from clothing, rugs, blankets and bedding.

Grease will come from unwashed hair; the hands of staff and customers; the creams, oils and emulsions used in the craft; floor and furniture polish; oil used to lubricate door hinges and equipment; food eaten on the premises.

Rubbish is a by-product of the work which goes on in the salon, dispensary, work rooms and staff rooms during the day and will include hair, cotton wool, crepe hair, cartons, boxes, paper, used sachets and pads, used paper towels and neck strips, bottles, corks, broken rollers, hairpins and crumbs from staff lunches.

SURFACES IN THE SALON

All these forms of dirt must be regularly and promptly removed from the various surfaces of the salon. These surfaces include basins, dressing-out tables, floors, walls, ceiling, chairs, mirrors, shelves, windowsills, workbenches in dispensary, laundry and postiche workroom, large equipment such as hairdriers and steamers, the reception desk, and the persons of the staff.

Since these surfaces are made of different materials, they will hold dirt differently and will have to be cleaned differently. Several factors besides resistance to dirt, however, must be considered when materials for surfaces are chosen in a salon. The best kind of flooring must be one which (a) can be easily swept and washed, (b) is impervious to water, (c) is resistant to acids

and alkalis used in the craft, (d) forms a safe surface on which to use electrical equipment, (e) is not noisy, (f) is comfortable to work on. A floor which is tiring to the feet of workers who stand all day is not a good salon floor however well it can be cleaned, and many impervious floor materials are noisy and are therefore not entirely suitable.

Dressing-out tables and other working surfaces must be made of a material which can be easily and thoroughly cleaned. Many of the new plastic materials are suitable for dressing-out tables and dispensary benches, but some of them are noisy. It is so important to be able to clean them easily that noise may have to be accepted. The hairdresser will learn to put down her tools quietly.

Walls must be impervious to water round the basins but may be of softer material elsewhere to deaden noise. Walls should be so finished, however, that they may be washed down when necessary. Plain colours are best for salon walls because dust deposits show up on them. The salon should be well ventilated so that condensation on walls does not occur.

Ceilings are usually of soft material which reduces noise, but they, too, should be pale in colour to show up dust.

The basins are usually made of glazed stoneware which is easily cleaned, but cracked and chipped areas may hold dangerous accumulations of dirt and grease.

Seats in the salon must be covered with material which (a) can easily be kept clean, (b) does not harbour particles of hair, (c) is resistant to dyes, acids, alkalis and fats, (d) will wear well, (e) is comfortable, (f) looks attractive, (g) can be replaced at reasonable cost.

REMOVING DIRT IN THE SALON

Dirt will be removed in a number of ways.

1. Some will be swept up and carried away.
2. Some will be burned.
3. Some will be broken up by abrasive powders.
4. Some will be dissolved by water or by other solvents.

5. Some will be emulsified by detergents.
6. Some will be carried out with air through extractor fans.
7. Some will be swilled away down water pipes from basins.
8. Some will be removed by several of these processes at the same time.

One of the first things a hairdresser learns is to remove dirt from human hair by shampooing. When she does this she uses water and a detergent of some kind—soap or a soapless cleanser.

The dirt in her customer's hair is a mixture of grease and dust. The grease comes from the sebaceous glands in the skin of her scalp and the dust comes from her surroundings and the work she does. The grease holds the dust, and the cuticle of each hair is covered with a film of the mixture.

The hair is wetted with warm water and a detergent is rubbed into hair and scalp with the hairdresser's fingers. The detergent dissolves and lowers the surface tension of the water. This makes it easier for the solution to flow around the scales of the hair cuticle and between the scales and the dirt. The grease is emulsified and some of the particles of dirt dissolve. The movements of the fingers and tossing the hair in the solution helps to loosen the more stubborn particles. The detergent surrounds those which cannot dissolve and holds them in the solution until the whole lather is swept away by the rinsing water. Several minutes of continual rinsing with a spray of clean water carries away the last traces of dirt. (See page 142 for an explanation of how detergents work and page 129 for an explanation of surface tension.)

This is not the place to give detailed instructions on cleaning the salon. Advice will be taken from manufacturers about the best way to clean the surface materials chosen and every member of the salon staff will be aware of the necessity for absolute cleanliness in every operation performed during the day's work.

Methods of cleaning must remove dirt and not just move it from one place to another. For instance, the floor of the salon needs to be swept constantly to keep it free of hair cuttings, but unless this is done carefully the air is filled with dust and hair particles, to the discomfort and danger of everyone in the room. The whole floor will be swept, probably by a vacuum cleaner, after working

hours. It should then be washed, and disinfectant used in the water. The junction of the floor and walls is an important point to note because cracks here can hold hair and dust.

Waste litter will be collected as it accumulates and placed in covered bins. These bins should be in good repair and the lids should fit closely. Pedal bins beside each dressing-out table are useful and they can be emptied as they fill up into larger covered bins which will be emptied at the end of the day. All bins should be thoroughly washed each day and disinfectant used. Some salons have chutes for hair and litter leading directly to a boiler house in the basement. These have doors designed to prevent dust flying back and to prevent smells from the basement entering the salon.

A great many soiled gowns and towels must be washed after every day's work. At least two clean towels are used for each customer, and if possible a clean gown should be used for each customer. Many salons use small paper towels to protect the customer's face during shampooing and use paper neck strips. These save laundering but increase the amount of refuse. Many salons have their own laundry room with washing and drying machines. Clean towels should be stored in a separate room so that used towels do not come into contact with them, and benches used for folding clean towels should not also be used for dirty towels.

Mops, brushes and brooms should themselves be washed frequently and disinfectant used in the water. The sterilization of tools used in the salon is discussed in Chapter XX (page 239) and the personal hygiene of members of staff is discussed in Chapter XIX (page 198).

WASTE PIPES AND DRAINS

Something should be said here about keeping clean the waste water pipes from the basins.

The waste water from basins flows into a pipe beneath the basins which leads to a large pipe running down the outside of

the building to the drain beneath the ground. A good deal of hair from shampooing falls into salon basins. Hair does not dissolve in water and if it is allowed to collect in the pipes it may make a felted mat which will collect soap and grease and block up the pipe. Hot water with washing soda dissolved in it can be poured down the basins to dissolve accumulated grease but this will not get rid of hair.

At intervals from the basin to the drain in the ground there are places where the pipes may be cleaned. It is a good idea to make cleaning the pipes a regular routine instead of waiting until they block up.

1. There should first be a filter in the plughole to catch hair and solid matter which may fall into the basin.

2. Underneath each basin is a trap. It is a bend in the pipe in which lie 2–3 inches of water. This water is called a seal because it prevents offensive gases from the drains entering the room. Traps are not all the same shape.

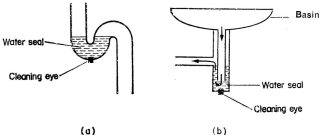

FIG. 1. *Traps; (a) an S-trap with water seal and cleaning eye, (b) bottle trap.*

3. At the lowest point of the trap there is a cap which can be unscrewed. The water of the seal will then run out and the pipe can be cleaned up towards the basin or towards the down pipe with a flexible wire spiral.

4. If there are several basins in a row they will all empty into one pipe which will take water from them all to the outside waste water pipe. This pipe will have cleaning eyes at the ends so that it can be cleaned with cleaning rods. When the salon is designed care should be taken to leave enough room between the end of the pipe and an adjoining wall to use rods on the pipe.

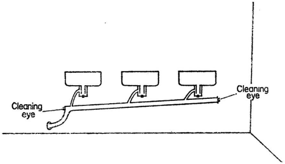

FIG. 2. *Row of basins with cleaning eyes.*

5. The waste water pipe on the outside of the building is a pipe about 4 or 5 inches in diameter. It has an open top which usually reaches above the gutter on the roof. The top is open to ventilate the pipe. This pipe ends at a gully trap. A gully trap is a short, wide pipe sunk in the ground with a grating on top to stop leaves and other rubbish falling into the trap. A pipe from the gully trap is water sealed underground and goes then to join the house drain at an inspection chamber. The waste water pipe either stops just above the gully trap so that water from it falls through the grating or, as is more usual from salon basins, it enters the trap just below the ground, in which case it is called a back inlet gully.

The gully trap should be cleaned out each week and hair and other deposits should not be allowed to collect in it or on the grating above it. A bucketful of hot water and washing soda should be emptied into it after cleaning.

6. Lavatories do not empty into the waste water pipe but into a different pipe called the soil pipe, and although there is a water seal at each lavatory there are no cleaning eyes in the pipe. There is no gully trap on a soil pipe. No hair, cloth, cartons, brown paper or newspaper should be put into lavatories because they will block up the pipe. If the lavatory does become blocked up,

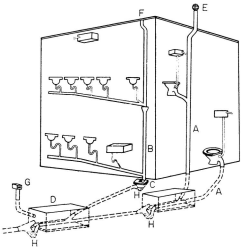

FIG. 3. *Waste pipes and soil pipes: A, soil pipe; B. waste pipe; C. gully trap; D. inspection chamber; E. ventilation for soil pipe; F. ventilation for waste pipe; G. ventilation for inspection chamber; H. waste seal.*

rods can be inserted into the pipe at the inspection chamber outside. Lavatory bowls should be cleaned daily with a suitable cleaning powder and a stiff brush.

Flexible rods for cleaning pipes can be bought and kept on the premises.

EXERCISES

1. Take a little dust from a windowsill or from the floor and sprinkle it onto water in a beaker. Watch how much sinks at once, sinks slowly, remains suspended in the water for some time, or floats.
2. Collect some more dust, scatter it on a piece of paper, and pass a magnet slowly just above the surface. Note if any particles are attracted to the magnet.
3. Put a smear of distilled water on a slide, sprinkle some dust on it, and look at it through a microscope with transmitted light, and with the iris diaphragm closed down. Note that the particles have different shapes and colours. Can you identify any of them?
4. Do the same as above but add a drop of iodine to the water. Have any of the particles turned blue? What do you learn from this?

II
THE HUMAN BODY

As a hairdresser you are interested in people's heads. But a living head is part of a living body and cannot exist by itself, so that it is useful to understand a little about how the whole body works.

SOME GENERAL OBSERVATIONS

Here are a few of the things we all know about a healthy, living human body:

1. It stands erect, balanced on 2 legs and feet.
2. It is firm and has shape—it is not soft and limp like a jelly-fish.
3. The body can move. It can move from place to place but even when it is standing in one place it can make large and small movements of many kinds, some of them very complicated.
4. It needs a constant, steady supply of air and has organs to supply it with this.
5. It needs to be nourished and so it regularly takes in a mixture of animal and vegetable foods.
6. It has organs inside it to digest and distribute this food to all its parts.
7. It needs a steady supply of water and it takes this in in many forms, for instance in food and as different beverages.
8. It rids itself of waste products in the form of breath, sweat, urine and faeces.

9. It is covered with skin. Hair grows from the skin all over the body except on the palms of the hands and the soles of the feet, but most thickly on the head.

10. It has sense organs through which it is in contact with the world around it. The large sense organs—the eyes, ears, tongue and nose—are all on the head. The organs of touch and pain are all over the body, mostly in the skin.

11. It does not act in a casual or unsystematic way, but plans and controls its movements.

12. It gets tired and needs rest.

13. It can be damaged and broken and can be attacked by disease.

14. It grows. From birth to maturity it grows in size and all its life parts of it grow continually, e.g. skin, hair, nails.

15. It can heal itself. It cannot grow a new limb but it can grow new tissue to heal a wound or to replace worn-out parts.

16. It can only work comfortably within a small range of external temperature. Its own temperature remains at around 98°F (36·9°C) so long as it is healthy.

CELLS, TISSUES AND ORGANS

So that you can understand a little about how the body works you must know something about cells, tissues and organs.

The body is made up of millions of very small living units called cells. They are made of living matter called protoplasm and are busily breathing, absorbing nourishment and working all the time. They are not all the same shape nor do they all do the same work. Each cell can divide into two similar cells and in this way the number of cells can be increased.

The cells are joined together to make what we call tissues and the tissues make up different organs, e.g. heart, liver, skin, kidneys. Each organ has a particular duty to perform in the body but they are all dependent on each other. Every part of the body is served by the transport system (the blood) which carries

nourishment, oxygen and other vital materials to every cell of every tissue in every organ, and carries away waste material.

Think of the body as a city. Each cell is like a house with a busy life of its own going on all the time. The houses are grouped into streets as the cells are grouped into tissues. The streets are grouped to form suburbs as the tissues form organs. Each part of the city lives its own life but contributes to the life of the whole. Deliveries of food go on all through the city, water and power are supplied to every house and waste materials are taken away in drains and by refuse collection.

The body has its own police and emergency services, too, because the working of the organs is regulated, invasions of disease organisms are resisted and loss of blood is stopped by substances in the blood. The life of the body is controlled by the brain as the life of a city is controlled by its local government authority.

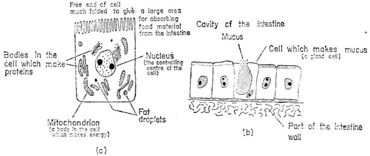

FIG. 4. *Cells and tissue:* (*a*) *diagram of a single cell from the lining of the intestine* (*very much enlarged*). *All the contents of the cell make up the protoplasm.* (*b*) *a row of cells making the lining of the intestine.*

THE SKELETON

The body is able to stand upright and has a firm shape because it is built round a framework of bones called the skeleton. The skeleton does three useful things for the body:

1. It supports it by making a strong, firm framework for it.
2. It gives the muscles something solid to be attached to so that they can pull the bones into different positions.
3. It protects important parts of the body which are soft and delicate. For instance, the skull protects the brain, and the rib-cage protects the heart and lungs.

Like all the hairy animals, man has a skeleton built on this plan:

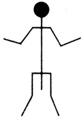

FIG. 5.

In man, the backbone, with the skull on top and the cage of ribs lower down, is sometimes called the axial skeleton and it supports the head, the neck and the trunk of the body. The arms and legs are called the limbs and are joined to the axial skeleton by the shoulder and hip girdles.

The backbone (also called the spine, or the spinal column, or the vertebral column) is not rigid. It is made up of 33 small bones called vertebrae. These are joined together so that although each one can only move a little, the whole column can bend and this allows the body to make a great many different movements.

Try to examine a human skeleton in the laboratory and count the vertebrae.

Five of the vertebrae are fused together to make part of the hip girdle and the last 4 are also fused together to form the small tail (called the coccyx) in which the spine ends.

The backbone is not in a completely straight line. If you look at one of your friends from the side you will see that her spine

curves slightly forward at the neck, curves backwards below the shoulders, forwards again at the waist and then backwards near

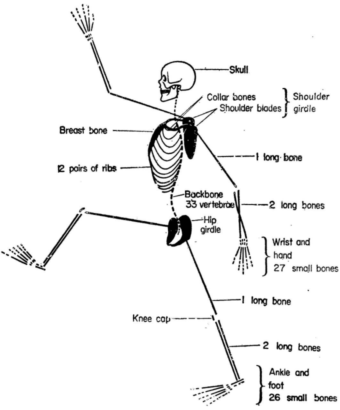

FIG. 6. *The human skeleton.*

the hips. This last part is where the 5 vertebrae are fused together. Below this the small tail curves inwards (see the backbone in Fig. 6).

There are 24 ribs, 12 on each side of the backbone. They are hinged to it in such a way that they can move a little up and down. Six of the ribs on each side are also joined to a bone in front known as the breast-bone. In this way they make a cage of bone which shapes the upper part of the body and contains the lungs and heart.

The shoulder girdle is made of several bones which include the collar bones in front and the shoulder blades at the back. The arms are attached to this girdle by joints which allow them to swing freely.

The hip girdle is a very strong ring of bone called the pelvis. It supports all the organs inside the abdomen. The legs are jointed into this girdle in such a way that they can move easily and can take the whole weight of the body.

Arms and legs have very much the same structure. Each arm and each leg has 1 long bone above the main joint (elbow or knee) and 2 long bones below it. Then there are 3 groups of small bones forming (1) the wrist or ankle (2) the palm of the hand or sole of the foot (3) the fingers or toes.

MOVEMENT—MUSCLES

Muscles are what we usually call flesh. We can feel them under the skin. They are made of fibres which are able to shorten themselves (that is, contract). The bony skeleton is covered with many groups of muscles often arranged in layers.

All our bodily movements, large and small, are caused by the contracting of muscles because this is the way that our bones are pulled into different positions. Each skeletal muscle is attached firmly at each end to a bone and when it contracts it pulls one bone closer to the other. For example, the biceps muscle in the upper arm draws the lower bone of the arm closer to the upper bone and bends the elbow. The ends of the muscles do not contract. They are made of strong, inelastic tissue and are called tendons. Some of the smaller muscles are joined at one end to a bone and at the other to skin so that when they contract the skin

is pulled into a new position. The muscles in the face work like this so we can smile or frown or "pull faces".

Very small muscles may be joined at each end to a layer of the skin. The tiny muscle which moves a hair is of this kind.

A muscle can pull bones but it cannot push them. Muscles usually occur in pairs so that one may pull the bones into one position and the other may pull them back again.

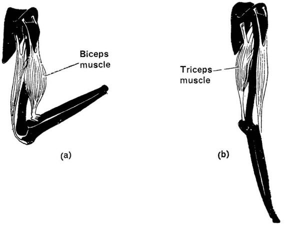

FIG. 7. *Arm muscles: (a) the biceps muscle contracts and pulls the lower arm bones up towards the upper arm; (b) the triceps muscle contracts and pulls the arm straight again*

A certain amount of heat is produced when muscles contract and the body sometimes quickly contracts and relaxes muscles in the skin for a short period to produce heat. This is what we call shivering.

Muscles of a different kind cause movements in the inside organs of the body without our having to think about them. For instance the heart is made of strong muscle which contracts rhythmically and steadily to pump blood round the body; and muscles in the walls of the digestive tube contract and relax in a

wave-like manner to move the food along. We do not have to remember to contract these muscles. They carry on their work by themselves so long as the rest of the body is healthy and undamaged.

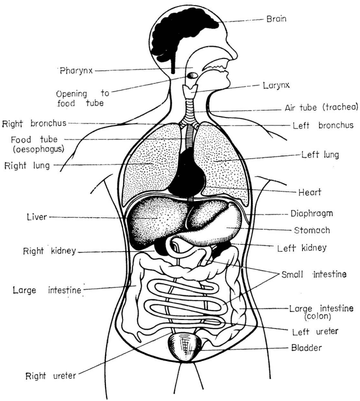

FIG. 8. *Diagram showing some of the main organs of the body.*

SOME OF THE MAIN ORGANS OF THE BODY

Figure 8 on page 17 is a very simple diagram. It is meant to show where in the body some of the important organs lie. As some of them lie behind others it is difficult to show them all, and it is useless to try to show too many, in the one diagram. Among others, the following things are left out:

Blood vessels; pancreas; reproductive organs; spleen; rectum.

Notes on some of the Main Organs

The Brain (a) is the seat of thought, judgement and memory; (b) interprets messages from the sense organs; (c) decides upon and controls all voluntary movements of the body; (d) controls such vital work of the body as breathing and beating of the heart, and maintains balance.

The Larynx is the voice box where sounds are produced when the air passes between vocal cords in it.

The Trachea or Wind Tube is a strong tube about 5 inches long through which air comes from the nose and mouth to the lungs. It divides into two tubes called the right bronchus and the left bronchus which go to the lungs.

The Oesophagus or Food Tube lies behind the trachea and leads from the mouth to the stomach. Food swallowed passes down this tube into the stomach.

The Lungs. These are the organs in which the exchange of gases between the air and the blood takes place. They expand and contract in the action of breathing.

The Heart pumps blood to all parts of the body.

The Diaphragm is a strong sheet of muscle which is like a floor to the chest and a ceiling to the abdomen (belly). It has three duties:

(a) to divide the chest from the abdomen; (b) to contract and move downwards to enlarge the chest space during breathing; (c) to help in sneezing, coughing and expelling faeces by contracting and thus pushing on other organs.

The food tube and the large blood vessels pass through it like pipes going through the floor from an upstairs room to a room below.

The Stomach. This is a bag-like part of the digestive canal. It digests food by churning movements of its strong muscular walls and by producing, from glands in its walls, digestive juices which break down the food.

The Small Intestine. (a) continues the digestion of food already partly carried out in the stomach; (b) lower down, it absorbs the useful part of the now liquid food into its walls and thence into the blood stream.

The Large Intestine or Colon absorbs water from the food material which remains after passing through the small intestine. It then sends this material as faeces on to the rectum to be emptied from the body.

The Liver. This acts as a factory and store house in the body.

It (a) makes bile which helps to digest fat in food; (b) alters food materials into forms in which the body can use them; (c) sorts them and stores some and sends others to other organs; (d) makes certain dangerous waste materials harmless and sends them to the kidneys to be excreted.

The Kidneys filter off impurities and waste products from the blood and send them, in the form of urine, through two tubes (the ureters) to the bladder.

The Bladder is a muscular bag-like organ which holds the urine until it is emptied.

DIGESTING FOOD

Every part of the living body must be nourished. This means that food must reach every cell of every organ. For instance, food must reach each cell in the dermal papilla at the base of each hair follicle and pass from these cells into the cells in the follicle which are making the hair.

The body takes in food which contains building material (protein) and energy-making materials (carbohydrates and fats)

for the body, but these materials are not in the form in which the body can use them. So the body first breaks them down (in the digestive tube) into the chemicals they are made of and then sends these chemicals to the cells. It is the blood which carries them to

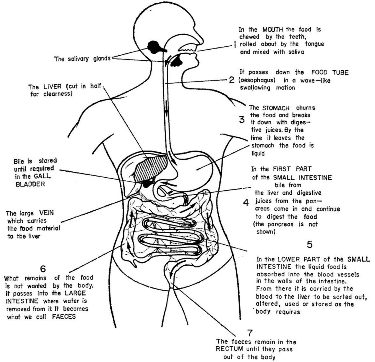

FIG. 9. *Simple diagram of the digestive organs.*

the cells. Each cell then builds the protein chemicals up again into the kind of protein it needs for its own substance and to make new cells, and uses the carbohydrate and fat chemicals for energy. (See Fig. 4 page 12). So the food we eat really does turn into our very selves.

The breaking down of the food is called digestion and this takes place in a long tube which runs through the body beginning at the mouth and ending at the anus. It is wider in some parts than others, and because it is longer than the body it has to lie coiled in the abdomen.

The food is broken down by this tube in two ways:

1. chemically by juices which are produced by glands in the walls of parts of the tube, and

2. mechanically by churning movements of the strong muscular walls of the tube.

When most of the food is made liquid it is absorbed into the wall of the tube, the indigestible parts being left behind. The absorbed liquid then passes into the tiny blood vessels in the wall of the tube and is carried to the liver which distributes it all over the body.

The parts of the digestive tube are named in Fig. 9. You may find that other books call the digestive tube the "digestive tract" or the "alimentary canal".

BREATHING

The body needs a constant supply of oxygen. Every part of the body needs oxygen even more urgently than it needs food. We cannot live for more than a few minutes without oxygen. The body can store food so we only need to give it fresh supplies at intervals but it cannot store oxygen and so it must have a steady supply entering the body. The food material cannot be used without oxygen. In the same way the tobacco in a cigarette will not burn unless air is drawn through it, and the petrol in a motor-cycle engine cannot be used unless air is mixed with it. The smoking of the cigarette turns the tobacco and air into heat and the mixture of air and petrol in the engine releases energy to drive the motor-cycle along. In each case there are waste products as well—ash and smoke in the cigarette and exhaust gases in the motor-cycle. In the body the food material and oxygen combine to form new substances and warmth and energy are released at

the same time. There are waste products here, also, and these are thrown out of the body by the lungs, kidneys and sweat glands.

$$\begin{matrix} \text{Food} \\ + \\ \text{Oxygen} \end{matrix} = \begin{matrix} \text{new cell material} \\ + \\ \text{warmth} + \text{energy} \end{matrix} + \text{water} + \text{waste}$$

Oxygen is a gas which is colourless and has no smell. Gases behave in certain ways:

1. A gas spreads out to fill the whole of any space available to it.

2. It flows as quickly as it can from a place where there is plenty of it to a place where there is less of it (e.g. a nasty-smelling gas escaping at one end of the salon can soon be smelt at the other end.)

3. It can pass through other gases, and through a very fine membrane if it is wet.

The only way the body can get the oxygen it needs is to take it out of the air.

Air is a mixture of several gases in the following proportions:

Nitrogen	78 per cent
Oxygen	21 per cent
Carbon dioxide and other gases	1 per cent

Some water vapour is present, too.

The body has in its blood a substance called haemoglobin which can separate the oxygen out from the other gases in the air. This is carried in the red corpuscles. The body therefore needs to bring air into contact with its blood so that the haemoglobin may pick up the oxygen. It does this by drawing air from outside into its lungs, which are like clusters of bags with very fine walls. These bags are called air sacs and they are surrounded by blood vessels. The blood in these vessels contains very little oxygen, so oxygen from the air passes through the walls of the air sacs into the blood where it is picked up by the haemoglobin. It is then carried by the blood to the heart and thence to all parts of the body. There is already nitrogen in solution in the blood and other body fluids and, as this is not used up by the body, no more nitrogen enters the blood from the lungs.

When the oxygen reaches a part of the body where there is no oxygen it passes out of the blood into the tissues of that part. Here it combines with food materials. When this happens, water and carbon dioxide are released. Carbon dioxide is a gas and, since there is no carbon dioxide in the blood at that point, it passes into the blood, which carries it back to the lungs.

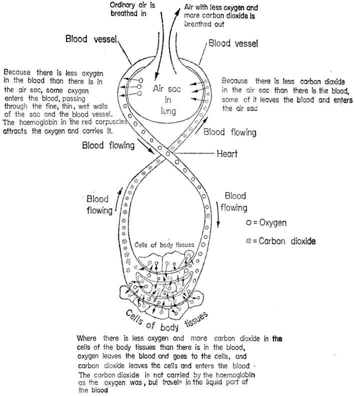

FIG. 10. *Diagrammatic representation of the oxygen–carbon dioxide exchange in the body.*

When the blood reaches the lungs there is less carbon dioxide in the lungs than there is in the blood, so the carbon dioxide in the blood passes out into the lungs and is driven out into the air.

The mixture of gases leaving the lungs is therefore different from the air which entered them. The proportions are now:

Nitrogen	78 per cent
Oxygen	17 per cent
Carbon dioxide	4 per cent
Other gases	1 per cent

The amount of water vapour has also increased.

The body has exchanged carbon dioxide for some of the oxygen.

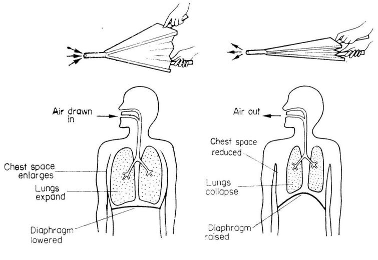

FIG. 11. *Breathing.*

Drawing air in and out of the lungs is called breathing. It is controlled by the brain without our conscious effort. It is a regular muscular movement which causes the chest to expand and contract rhythmically rather like the opening and shutting of a pair of bellows.

Air is drawn in because the chest space is enlarged and this makes room for more air, which pours into the lungs through the nose and throat.

The chest space is enlarged because: (a) the muscles between the ribs contract. This swings the ribs up a little, enlarging the width of the chest; (b) the diaphragm contracts and this increases the depth of the chest space.

When the muscles and the diaphragm relax again the chest space grows smaller and air is pushed out of the lungs.

ELIMINATION OF WASTE PRODUCTS FROM THE BODY

Wherever there is work done there is likely to be waste material to be disposed of: e.g. in a salon at the end of the day's work there is a lot of rubbish to be thrown out. In the same way, as the body works, it produces unwanted waste products.

The body eliminates (gets rid of) these waste products in four ways:

<table>
<tr>
<td>
1. Through the lungs. Carbon dioxide is collected here and breathed out.
2. Through the kidneys. The blood carries waste products from all parts of the body to the kidneys. Here they are filtered off from the blood and passed out of the body via the bladder in the form of urine.
3. Through the skin. The sweat carries out some impurities. It is like very much diluted urine.
</td>
<td>after the digested food has been used</td>
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4. Through the bowels. The faeces are mostly made of unused food which the body does not need.

BLOOD

Blood is a liquid which travels round the body in tubes. Some of these tubes are large—thicker than a finger—and some are

thinner than a thread. They form a fine network all over and through the body and the blood races through them, pumped regularly by the heart.

The blood exists to carry things from place to place in the body and to bathe the tissues constantly with salt water.

The blood carries

1. oxygen from the lungs to all parts of the body
2. food from the liver to all parts of the body
3. waste material from all parts to lungs, skin and kidneys where they are thrown out of the body
4. hormones. These are substances made by particular glands in different parts of the body. They are necessary to control the working of the body.
5. white corpuscles and anti-bodies which protect the body against infection
6. material to make the blood clot. This stops it running out when the surface of the body is wounded and blood tubes are cut.
7. heat from hotter to cooler parts of the body. This distributes the heat and keeps the temperature of the body even.

The blood bathes the tissues in salty water by allowing part of its liquid to ooze through the sides of the tubes. This liquid carries dissolved food material and oxygen and as it flows over and between the cells of the tissues they take whatever they need from it and give out into it waste material they want to be rid of. Some of the liquid filters back into the blood tubes carrying part of the waste material with it, and some of it flows away along other channels called lymph vessels. These pour it back into the blood-stream in another place.

Blood is made of:

1. A salty liquid called plasma which is mostly water. It is this liquid which carries in it the food materials and waste products already mentioned.
2. Solid bodies floating in the plasma. These are (a) *red corpuscles:* These are cells shaped like small discs, hollowed a little on each side so that their edges are thicker than their middles. They contain a dark bluish material called haemoglobin. It is this material which attracts oxygen from the air in the lungs and

holds it until it reaches parts of the body which need it. Then it lets the oxygen go. While the red corpuscles hold the oxygen they are coloured a bright red but when the oxygen leaves them they lose their red colour and are dark bluish again. There are many millions of red corpuscles in the blood. (b) *white corpuscles:* These are larger cells than the red corpuscles and there are fewer of them in the blood. They fight germs which cause disease. They can pass through the walls of the blood tubes in order to reach germs among the cells of the tissues. (c) *platelets:* These are very small, round or oval bodies which help the blood to clot if a blood tube is cut. The clot then plugs the hole in the tube and prevents the blood from escaping.

The heart is the centrally placed pump which sends the blood through the tube-like vessels. It is made of thick muscles which contract regularly about 70 times a minute. If you could cut open a heart you would see that it is something like a four-roomed house with two rooms below and two above. There is a strong wall between the rooms on the left hand side and those on the right but there is an opening in the floor of each top room, leading to the room below. This opening is closed by a valve which opens downwards if pressed on but which cannot open upwards.

The two top rooms (or chambers) are called the auricles and the two lower ones are called ventricles.

Large tubes (or vessels) bring the blood into the auricles and others take it away from the ventricles.

Blood comes from the lungs carrying oxygen and enters the left auricle of the heart. The muscular walls contract and the blood pushes through the valve into the ventricle below. The muscles in the walls of the ventricle contract and spurt the blood into the great artery leading away from the heart. This artery is called the aorta. The blood courses quickly along the artery, some running off in branches to the head, arms, internal organs and down to the legs and feet. Each time the artery branches the new branch is narrower until at last the blood is travelling through a very great number of tiny narrow tubes, the capillaries. Here it gives up its oxygen and collects carbon dioxide. Gradually the blood flows into bigger and bigger vessels again. This time they

are veins and not arteries. Branches join the flow, pouring in more blood from organs, limbs and head, until it is poured into the right hand auricle of the heart. The muscles contract, the blood pushes through the valve into the ventricle below and from there is pumped by the contraction of the ventricle walls into a large artery which takes it to the lungs. Here the blood gives up its load of carbon dioxide and takes up a fresh supply of oxygen and the journey is repeated.

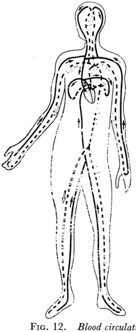


FIG. 12. *Blood circulation.*

You can see that the circulation of the blood is a double one—(1) from the heart to the body and back to the heart, (2) from the heart to the lungs and back to the heart.

During its journey through the body the blood collects and distributes all the other substances besides oxygen which it carries for the tissues.

THE NERVOUS SYSTEM

All the work and movement of the body is controlled by the brain which sends directions to every part of the body. The brain lies inside the skull, and an extension of it, called the spinal cord, runs downwards through a canal in the bones of the spine (vertebrae) rather like a piece of thick string running through a row of cotton reels.

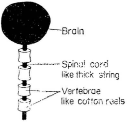


FIG. 13. *Brain and spinal cord.*

From the brain and spinal cord there come pairs of nerves which look like thick white strands of cotton. Each nerve is a bundle of many finer strands called nerve fibres. These separate out from the nerve bundles and go to different parts of the body until every organ and muscle and part of the skin has nerve fibres ending in it. Messages from the brain come along some of these fibres.

The brain cannot send useful messages to the body unless it has accurate information about the world outside. On the surface of the body are sense organs. They collect information and send it to the brain along others of the nerve fibres.

Light, reflected from objects around, enters the eyes.

Sounds are picked up by the ears.

Smells of all kinds enter the nose.

Tastes are received by the tongue.

These sense organs are all on the head.

But other sense organs are all over the surface of the body, in the skin, and in each hair. They distinguish heat, cold, pressure and pain. Some parts of the skin have more of these organs than others. For instance the tips of the fingers are especially sensitive and we therefore use them to feel and touch with.

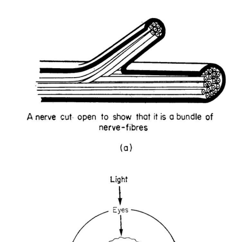


FIG. 14. *Sense organs and brain.*

So we can sum up like this;

1. Nerve fibres in the sense organs pick up sensations from the outside world.
2. They pass these on to the brain.
3. The brain sorts out the sensations and interprets them.

4. The brain then sends orders along other nerve fibres to muscles so that they move the body in whatever way the brain has decided is necessary.

An example of this would be: A customer sits in front of you. Your eyes pick up light reflections from her hair and pass these sensations on to the brain. The brain interprets these as a picture of her hair, decides the hair is too long and sends orders to the muscles of your body which cause it to pick up the comb and scissors to cut the hair.

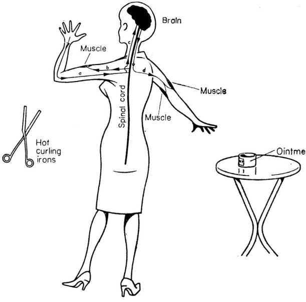


FIG. 15. *The burnt finger (girl dropping tongs): a. message of heat goes to spinal cord; b. message from spinal cord to muscles of arm; c. message of pain to brain; d. message from brain muscles of arm and hand*

Sometimes messages from the sense organs do not have to go as far as the brain before an order can come back to the muscles.

The spinal cord can deal directly with some messages. For instance your hand touches the heated end of a curling iron. The heat nerve endings in the skin flash a message to the spinal cord which immediately flashes an order to the muscles of the arm to remove the hand. At the same time part of the message does go on to the brain, and the brain sends out the orders to the muscles which cause you to go and get some ointment to put on your hurt hand.

Certain parts of the brain receive all the messages from certain parts of the body. For instance all messages from the eyes are received in one area of the brain and all messages from the ears are received in another area of the brain.

All the many fibres sending messages from an eye are collected into one large bundle called the optic nerve, so we have two optic nerves going, one from each eye, to the brain. This means that blindness may be caused by (a) damage to the eyes themselves or (b) damage to the optic nerves or (c) damage to the part of the brain which receives the messages from the eyes.

Accident or disease may cause the damage, and of course the same kind of thing may cause deafness if the ears, or the nerves from the ears, or the part of the brain which receives messages from the ears are damaged.

Other parts of the brain are concerned with thinking, recognition and memory. Yet other parts of the brain receive constant messages from the internal organs of the body and send constant messages to them so that our heart, lungs, liver, stomach, kidneys and intestines do their work without our having to think about them.

THE SKIN

The skin covers the whole body and it is so important and has such a distinctive structure that it is described as one of the organs of the body. It is of particular importance to the hairdresser and so it will be discussed in a separate chapter.

REGULATION OF BODY TEMPERATURE

The temperature of the healthy body remains steady at around 98·4°F (36·9°C) although it varies a little during each 24 hours. The body maintains this temperature even though the temperature of its surroundings may be higher or a good deal lower.

Body heat comes from the using up of food, the body's fuel. This is carried on mostly in the liver and the muscles, and the blood, as it circulates, carries the heat round the body so that it is distributed evenly.

The body is losing heat all the time because every time we breathe out some heat is lost with our warm breath. Urine and faeces are also warm and take some heat from the body as they leave it. Heat is also lost by radiation, conduction and convection from the surface of the body. So heat is being made and lost all the time by the body itself, but the body's surroundings are at the same time either cooling it down or warming it up. How does the body manage to keep its temperature so steady?

Deep in the brain there is a group of cells which acts as a temperature regulation centre. It reacts very quickly to the temperature of the blood wh'ch flows through it and, by using the nervous system, it causes parts of the body to perform certain actions which help to adjust the temperature. It cannot control the loss of heat through breath, urine and faeces but it can control the use of fuel and the loss of heat from the skin.

This is what takes place.

If the temperature outside the body falls so that the body is losing too much heat, the blood flowing through the temperature regulation centre shows a fall in temperature. The temperature regulation centre at once

1. causes the blood vessels in the skin to constrict so that less blood can flow through them. Therefore there is less heat lost from the skin by radiation, conduction and convection.

2. causes the tiny muscles to pull the hairs on the surface of the body upwards in an effort to collect air between them. (This is not successful because our body hair is not thick enough to

trap air. The action of the tiny muscles causes what we call "goose flesh".)

3. causes the muscles of the body to contract and relax rapidly (that is, to shiver). This work they do produces heat, as any physical work does.

4. causes the liver to release some easily used food material (fuel) into the circulation.

When the temperature outside the body rises to a degree that prevents the body losing enough heat, or when the body works so hard that it produces too much heat, the blood flowing through the temperature regulation centre shows a rise in temperature. The temperature regulation centre at once

1. causes the blood vessels in the skin to expand so that more blood flows through them and more heat can be lost from the surface of the body.

2. causes the sweat glands to pour out more sweat which evaporates and lowers the temperature of the body.

We use our intelligence, of course, to help the body to maintain its temperature. For instance we put on extra clothes when we feel cold or we light a fire or turn on some form of external heat. Clothes hold a layer of still air between them and the body and this slows down its loss of heat.

In very hot weather it is hard for the body to maintain its temperature because if the temperature of the air outside the body is higher than the temperature of the body, the body cannot lose heat into the air. If the hot air is dry, sweat evaporates and that lowers the body temperature, but if the hot air is very moist then sweat cannot evaporate because the air cannot hold any more water vapour. If the air is moving, some sweat will evaporate, so that moving the warm air about with fans helps a little.

People living in hot, moist climates have to be careful about doing too much hard physical work during the hottest part of the day because their bodies cannot lose heat. The temperature of their bodies rises and they feel ill and may even suffer from a condition known as heat stroke.

III
THE HEAD

BECAUSE as a hairdresser you are particularly interested in the heads of your customers, you need to know in more detail something about the structure of this part of the body.

You know, by holding it between your hands, feeling it with your finger tips and massaging it, that the head has a firm foundation of bone and that the scalp can be moved about on this foundation. You know, too, that the top of the scalp is skin and that the hair grows from this skin. There are, then, several layers of material under your hands.

BONES OF THE HEAD

The bony part of the head is called the skull and it is balanced on top of the backbone. We can see two main parts when we examine a skull. One is a hollow, curved box of bone to hold the brain; this is called the cranium. The other part is the face.

The Cranium

The cranium is made up of a number of wide, curved bones which together make a complete box. The bones you can feel when you shampoo a head are those on the top, front, back and sides of the cranium. The underneath ones are hidden by the

neck. You should know the names of the bones you can feel. There are eight of them and they are firmly joined together at their edges, which are irregular and fit together rather like a jigsaw puzzle. These joins are called sutures.

If you place your hand on your forehead you are touching the frontal bone of your cranium

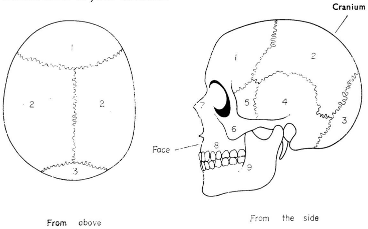


FIG. 16. *Some of the bones of the skull:* 1. *Frontal bon* ; 2. *Parietal bone;* 3. *Occipital bone;* 4. *Temporal bone;* 5. *Sphenoid bone;* 6. *Cheek bone;* 7. *Nose bone;* 8. *Upper jaw;* 9. *Lower jaw.*

Hold the back of your head in your cupped hand. This is the occipital bone you feel.

Press the tips of your fingers on each side of the top of your head. You are feeling the two parietal bones, one at each side. They join together along the top of your skull.

Now feel the bones around and above your ear on each side of your head. These two bones are called the temporal bones.

Just in front of the temporal bones are your temples, and these are the sphenoid bones. They are really two wings of a bone which is shaped something like a bird. The main body of this bone forms part of the underneath part of the skull and you cannot feel it.

Now look at a skull in the laboratory and see whether you can identify these bones. In the skull you will also be able to see the sutures. Turn the skull upside down and look at the bones underneath it.

The Face

There are fourteen bones in the face but it is not necessary for you to know their names. It is easy to feel the main ones which give shape to your own face. Beneath the eyes you can feel the cheekbones. Most of the nose is made not of bone but of the softer material called cartilage, but if you feel upwards along the nose you will feel a bony arch at the top where two nasal bones join to make the bridge of the nose.

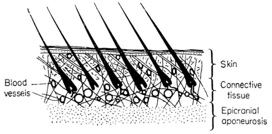
The other important face bones are the upper and lower jaw bones. The lower jaw bone is hinged so that it can be moved up and down and from side to side. This makes it possible for us to bite and chew many different kinds of food, and it also helps us to talk clearly. It is easy to feel where it is hinged.

The eye sockets in the skull are called the orbits.

The Scalp

Over the frontal bone, that is, on the forehead, is a muscle (the frontalis muscle) which we use when we pull our scalp forwards. It is connected below to muscles and skin round the eyes, and above it is connected to a broad sheet of tough tissue which covers the skull and is only very loosely attached to it. This sheet of tissue is called the epicranial aponeurosis and you should try to remember this name because every time you shampoo or massage the head of a customer you move this aponeurosis over the bones of the skull and you can feel yourself doing so. When you frown or raise your eyebrows you can feel your own epicranial aponeurosis moving as the muscles in your forehead pull on it.

An aponeurosis is a broad sheet of tendon. It is not elastic like the muscles themselves and it is very strong. The aponeurosis on the skull is described as "epicranial" because "epi" means "on top of" and so "epicranial" means "on top of the cranium".



A small section of scalp enlarged to show how the blood vessels travel in spaces between tough strands of connective tissue

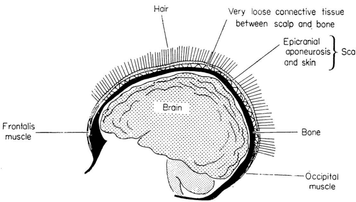


FIG. 17. *The scalp.*

At the back of the head the epicranial aponeurosis is connected to the muscle which covers the occipital bone (the occipitalis muscle); at the sides it blends loosely with the tissues covering the muscles over the temporal bones. Alternate contractions of

the frontalis and occipitalis muscles pull the scalp forwards and backwards over the skull. Some people can use these muscles more freely than other people can.

The skin is firmly attached to the upper surface of the aponeurosis by tough connective tissue strands, and together they make what we call the scalp. The scalp is rich in blood vessels which enter its base at the front, sides and back of the head. The smaller blood vessels from all sources join freely with one another and they travel in spaces provided by the tough strands of connective tissue binding the skin to the epicranial aponeurosis. These spaces are so rigid that, should the scalp be lacerated, the arteries cannot retract, which they can do in skin in other parts of the body and which minimizes the loss of blood from them in those parts. Therefore wounds in the scalp bleed freely and the only way to stop bleeding is to apply firm pressure over the injured zone and get medical help as soon as possible.

MUSCLES OF THE FACE

Muscles in the head are mainly concerned with (1) moving the lower jaw so that the mouth can open and shut and make chewing movements, (2) moving the tongue and pharynx so that we may talk and swallow, (3) moving the eyes in their sockets, (4) moving the skin of the head and face to make different facial expressions. Because as a beauty expert you are concerned with the appearance of your customer, it is in this last group of muscles that you are mainly interested, and they are the only ones we need discuss.

Below the forehead the face muscles are concentrated round the eyes and mouth, because those are the features most concerned in changing expressions.

A broad thin ring of muscles surrounds each eye. This allows the eyes to be narrowed and screwed up or to be opened very widely. Part of this muscle also allows the eyelid to open and close.

Another ring of muscle surrounds the mouth and there are several groups of small muscles which radiate from this one. These

are attached at their other ends to the cheekbones of the face and when they contract they pull the skin around the mouth into different positions. There are also small muscles in the lips which can tighten the lips when they contract.

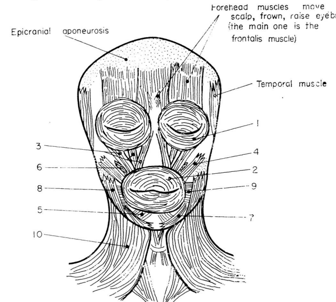


FIG. 18. *A simplified diagram showing some muscles of the neck and face: 1. Circular muscle of eye closes eye and shuts eyelid; 2. circular muscle of mouth—used to close mouth, pout, speak, suck, whistle, kiss, and in a great many facial expressions; 3. group of three muscles used to raise the upper lip; 4. laughter muscle; 5. pulls lower lip down; 6. draws corner of mouth upwards; 7. draws corner of mouth downwards; 8. pulls lower jaw upwards; 9. pulls mouth sideways—also used in blowing; 10. pulls angle of mouth strongly down and out, as when cleaning the lower teeth or looking terrified. Also lifts skin of chest.*

The result of the action of all these muscles is that we can smile, pout, frown, look miserable, angry or disagreeable. The muscles round the mouth also help us to control the amount of air going in and out so that we can blow out a match or whistle.

THE NECK

We have not said anything about the neck, but it is obvious not only that this is an extremely important part of the body but also that it is a most vulnerable one—that is, it can easily be hurt and is not well protected. Think of all that has to be carried in the neck. First the spine holds it firm and upright, and the head is balanced upon the spine. The precious spinal cord runs from the brain down through this neck section to the rest of the spine in the body. Nerves to control most of the body's automatic functions travel through the neck from the brain to the lungs, stomach, intestines, liver, kidneys and heart. All the blood the head and brain need must come and go from the heart through vessels in the neck. The two vital tubes carrying air from the nose to the lungs and food from the mouth to the stomach must pass through the neck. Then there are layers of muscles in the neck which control all the movements of the head as in bending and turning, nodding and shaking, chewing and swallowing, breathing and talking.

Look at a diagram in a good anatomy textbook which shows the muscles and blood vessels in the neck.

IV
THE SKIN

THE hairdresser is so much concerned with the skin of her customer that she must know as much as possible about it. We shall first make a list of things we can all observe about skin and then we shall discuss its function and then go on to consider its structure.

GENERAL OBSERVATIONS

1. It varies in thickness and texture. In some places, the lips and eyelids, for example, it is fine and thin. In other places, such as the palms of the hands and soles of the feet it is thick and looks coarser. Hairy skin is always thin.

Skin everywhere tends to grow thick and more heavily cornified if it is continually rubbed and pressed, so that the work a person does may affect the thickness of his skin in the parts of his body he uses for his work.

External factors such as sun and wind can cause skin to become flaky and rough but this can usually be cured easily. Some people inherit a scaly skin and this is not so easily remedied.

In some areas of the body the skin looks and feels smooth but in other parts it is rigid and creased. The palms of the hands and fingers show this. The fine furrows and ridges on the skin of the finger-tips lie in patterns and each person is born with a fixed pattern which does not change. Everyone has heard of "finger-

prints" and the use that is made of them to indentify individuals.

2. Skin also varies in colour. The colour does not vary only from person to person or from race to race but it is different in different parts of the same body. Variations in colour from person to person are caused by inherited characteristics, by age, by sex and by external factors such as climate and exposure to sun and wind. "White" parents will have "white" children, but a "white" person who works indoors all the time will have a paler face than another "white" person who works out of doors all the year round.

Variations in the colour of skin in different parts of the same body may be caused by several things. One is variations in the thickness of the skin. When the outer layer of the skin is very thick it tends to look yellow but where it is thin it looks pink or reddish because the colour of the blood in the deeper layers can be seen through it. You have only to look at the soles of your feet and your lips to see this difference in colour.

Disease often has the effect of changing the colour and appearance of the skin. A feverish person may look flushed; a person suffering from nervous tension or shock may look very pale; in measles a characteristic red rash comes out in the skin; jaundice causes the skin to look yellow; certain heart or lung conditions cause areas of the skin to look blue because there is not enough oxygen in the blood reaching them.

3. Skin is supple and elastic. We know this must be so or it would not be easy for us to move all the parts of our bodies so freely. When a part of the body swells, as in mumps, or after an injury, the skin stretches but usually goes back to its original size without leaving scars. Pregnancy, however, may stretch the skin so much that scars remain permanently. In old age the skin loses some of this elasticity and so it sags, and wrinkles appear. There is some evidence that strong sunlight over a long period has the effect of reducing the elasticity of the skin.

4. The skin gives out a greasy or oily substance. This is given off all over the body and keeps the skin supple, but it is given off much more freely on the scalp and face than anywhere else. The scalp can quickly become greasy. Many women complain that

parts of their face, for instance the forehead and nose, are oiler than the rest of the face and this causes difficulty with their make-up. Two kinds of cosmetics sometimes have to be used on different parts of the same face.

The soles of the feet and the palms of the hands are the only parts of the body where this oily substance does not appear.

5. The skin gives off liquid in the form of sweat, which is salty to the taste. It is produced by the skin more abundantly in conditions of high temperature and strenuous activity but it can also appear in certain areas of the skin during times of nervousness and fear.

6. The skin does not get wet easily. Water tends to run off it and so the body has a ready-made waterproof covering.

7. We know that hair and nails grow from the skin. Hair grows over most of the body, although most of it is fine and not easily seen. There is none on the soles of the feet, the palms of the hands and the lips. The skin of the head normally produces more than any other part.

8. Healthy skin repairs itself. Slight injuries such as surface cuts and scratches heal quickly and leave no trace. Deeper cuts heal but may leave scars.

9. Skin is sensitive to changes in temperature, to pressure (touch) and to pain.

10. The skin is sometimes invaded by parasites such as viruses, bacteria and plants, and we see evidence of this when warts, boils or ringworm appear. It can be attacked by small animals such as mosquitoes and head lice, and suffer slight damage from their stings. The itch mite can burrow and make tunnels in the skin. The chief dangers of these breaches in the body's covering is that infection may enter through them and harm the body itself.

FUNCTIONS OF THE SKIN

1. The skin protects the rest of the body from dirt, wetness and minor injuries such as scratching and slight burns. It protects the body also to a large extent from infection because it forms

a first barrier of defence against germs where the resources of the body can fight the invasion. In most cases of germs invading the skin they get no further, and the rest of the body is unharmed.

2. The skin prevents the body from losing too much water. The outer layer of skin acts as a covering to prevent the body fluids evaporating. The tissues of the body must be kept wet, and if they are not covered by a dry outer layer of skin they would dry up in the air surrounding the body.

3. At the same time the skin helps the body to get rid of its waste products. It does this by washing some of them out with sweat. Sweat is mostly water, but this loss of water is controlled and is not an unrestricted loss of body moisture.

4. The skin helps to keep the temperature of the body at a steady level. When the body becomes overheated—by strenuous exertion such as running, playing games or working hard, or by sitting in hot sunshine, or working in an overheated room, or by a feverish illness—the skin opens its pores and pours out sweat over the surface of the body. The sweat then evaporates, using up heat by doing so, and so the temperature on the surface of the body falls and the body feels cooler.

5. The skin detects changes of temperature and pressure from the outside world and sends messages to the brain describing these changes. The brain interprets these messages and in this way the skin acts as a sensitive barrier between the outside world and the rest of the body. Pain is a sensation reported when the stimulus is so great that injury is either imminent or has just occurred. As the result of reflexes, the nervous system has usually caused the body to remove itself from the source of the stimulus before the pain is felt and reported. (See Fig. 15.)

It is a *change* in temperature that is detected by the skin and not just temperature itself. This means that the skin quickly gets used to the temperature of whatever it is touching for any length of time. The hairdresser has her hands in warm water a good deal and after some time her hands may not be so sensitive to the temperature of the water as are the heads of her successive customers. She must therefore be careful to enquire whether the water is too hot or too cold.

6. Vitamin D can be formed in the skin by the action of sunlight or artificially produced ultra-violet rays.

THE STRUCTURE OF THE SKIN

The Layers of the Skin

If you could take a piece of your customer's scalp, cut a fine slice from it downwards, like cutting a slice of bread, and then look at this thin slice under a microscope, you would see something like the diagram, Fig. 19.

You see that it is made up of cells arranged in four main layers. The topmost, fairly thin, layer is called the epidermis, and this seems itself to be in layers when looked at closely.

The next, thicker, layer is the dermis. You remember that "epi" means "on top of", so the epidermis is the layer on top of the dermis. These two layers make up the skin.

Below the dermis is a layer of looser tissue called the subcutaneous (below skin) tissue, and below that is denser tissue which is called aponeurosis. (See page 38.) The boundary between the epidermis and the dermis is clear, but the boundaries between the other layers are not so clear and definite. Skin in other parts of the body would have a subcutaneous layer, but this would have some other tissue such as muscle beneath it instead of the aponeurosis of the scalp.

Most of the epidermis is dead. Every time you comb the scalp, flakes of this dead skin come off. This happens, too, when you scrub your hands with a nailbrush or rub any part of your skin. The top layer is always being rubbed off. The lower layer of the epidermis, however, is alive. It is a layer of cells called the stratum germinativum or germinating layer, and here cells are continually dividing into two so that new cells are being formed, and these are pushed upwards by the next new ones to be made. As they are pushed towards the surface of the epidermis they move further and further away from their food supplies and they gradually die, changing as they do so into a softer form of the same horny material as hair is made of, a material called keratin. When the dead cells reach the surface they flake off or are rubbed off.

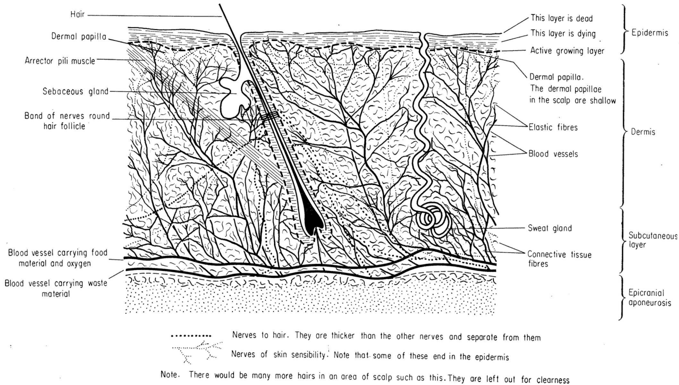


FIG. 19. *A section of skin from the scalp.*

The stratum germinativum is a most important layer of cells because from it are made hairs, oil glands and sweat glands, as well as new layers of epidermis cells. It is an extremely active layer of cells and needs much nourishment. This it receives from the dermis below. The epidermis itself contains no blood vessels, so it must receive food and oxygen from the blood vessels of the dermis, of which there are a great many. The dermis does not lie flat where it joins the epidermis, but pushes up into it in a series of projections called papillae. In these papillae are numerous blood vessels. Fluid carrying food and oxygen seeps through the walls of the tiny blood vessels and finds its way through spaces between the cells of the stratum germinativum and around the newly made cells just above them. But it cannot go much further than this and so the cells above receive little or no nourishment.

You will see that hairs, oil glands and sweat glands appear to lie in the dermis or even right down in the subcutaneous tissue, but these are all downgrowths of the epidermis and each one is enclosed in the active growing layer of the epidermis. So that the dermis pushes up into the epidermis and the epidermis grows downwards into the dermis, but they remain distinct from each other.

The dermis looks rather like a dense network of fibres. It has a great many elastic fibres in it and these are particularly numerous just where the dermis and epidermis meet, and they help to keep the two layers firmly attached. It is these elastic fibres that make the skin so supple and able to stretch so easily. The papillae of the dermis are largest in places where the epidermis is thickest. In the scalp they are shallow.

The Blood Supply of the Skin

Although the epidermis has no blood supply, the dermis is richly supplied with blood vessels. Arteries in the subcutaneous layer send branches up into the dermis and these branch into many smaller vessels so that in the upper part of the dermis there is a network of tiny vessels called capillaries. It is fluid from these

which nourishes the active cells of the epidermis. Waste products from these cells pass back into the capillaries and are drained away into tiny veins that join up into a network of larger veins and pour the blood into large veins in the subcutaneous layer which take it back to the heart. Branches from the network of blood vessels also go down to sweat glands and hair follicles deep in the dermis. (See Fig. 19.)

Nerve Supply of the Skin

There is a rich supply of nerves to the skin especially over the scalp and face. This is to be expected since we know it is a sensitive organ and can quickly detect small changes in temperature and pressure around it, so that we become aware of heat and cold and can use the different degrees of pressure, especially with our finger tips, to explore our surroundings by touching them. We know that messages of this kind are sent to the brain by way of nerves.

A complicated network of nerve fibres is found in the dermis, but there are few in the epidermis. You remember that nerves do two things. They send descriptions of their surroundings to the brain and they carry messages from the brain to muscles. Nerves in the skin carry orders from the brain to muscles attached to hairs, some of them very tiny, and to glands and blood vessels which can contract and expand. Other nerves end in the skin itself and are concerned with what is called skin sensibility. This means that they send descriptions to the brain about touch, pain, cold and warmth, but the nerves are so branched and are arranged in the skin in so complicated a manner that it is not clear exactly how this is done. We can see with powerful microscopes that the nerve fibres end in different ways in the skin. In hairy skin, for instance, some nerve endings form a band like basketwork in each hair follicle, and others seem to end freely in twig-like patterns. In non-hairy skin they can be seen to end in other patterns, but it is not yet clear exactly what each pattern signifies.

Colouring of the Skin

The skin contains a pigment called melanin which may be yellow, brown or black. This is found as granules in the lowest layers of the epidermis, that is, the germinating layer and cells just above it. In "white" races there is a small amount of melanin and in the darker races there are larger amounts and the pigment is spread through more of the epidermis. Skin in some parts of the same body has more melanin than skin in other parts and the amount can be increased, temporarily at least, by sunbathing.

Glands of the Skin

Glands are groups of cells which are specially set aside to produce chemical substances. There are two kinds of glands in the skin: sebaceous glands and sweat glands. The sebaceous glands are mostly connected with hair follicles (see page 56) but there are a few in the non-hairy parts of the skin, except on the palms of the hands and the soles of the feet, where there are none. They occur most thickly in the scalp and on the face. They give off the oily substance which lubricates the hair and skin and makes the surface of the skin slightly more waterproof. This substance is called sebum.

Sweat glands occur all over the skin in great numbers, but there are more of them on the palms of the hands and soles of the feet than anywhere else. They are coiled tubes which lie in the dermis and lead upwards through the epidermis to open on the surface of the skin. (See Fig. 19.)

Another, larger type of sweat gland occurs in the skin of the armpits of adults, and these give out a different kind of sweat which contains less water and more oily material than the ordinary sweat. The smell of this sweat is stronger than that of sweat from the smaller glands. Sometimes these larger sweat glands (which are called apocrine sweat glands) open into hair follicles instead of onto the surface of the skin.

The wax produced by the skin around the external opening of the ear, and the milk made in nursing mothers' breasts are both made by sweat glands altered for these particular purposes.

AGEING OF THE SKIN

As a person grows older changes can be seen in the skin. A few of them are: (a) the elastic fibres in the skin lose their elasticity and the skin begins to wrinkle, (b) some changes in the types of nerve endings can be seen from early childhood onwards, (c) apocrine sweat glands do not develop until puberty and tend to disappear in old age, (d) the distribution of colouring matter in the skin changes. Areas of skin may grow darker and new spots and blotches of colour appear as age advances, (e) changes in the skin of the scalp, particularly in men, can be seen. In children the epidermis of the scalp is quite thick and grows thicker as the boy grows up. In an old man the epidermis is much thinner.

NAILS

Nails grow on the last section of each finger and toe—that is, the section furthest from the body.

A nail grows from the epidermis. The root of the nail lies under a fold of skin called the nail fold and it is from this root that it

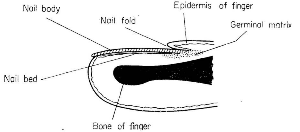


FIG. 20. *Diagram of finger tip showing nail.*

grows. The root is part of the germinating layer of the epidermis and is known as the germinal matrix. Here the cells are actively dividing and as each layer of cells is pushed on by the next layer, they become hard and horny. Thus the nail grows outwards from the matrix towards the tip of the finger or toe. Part of the matrix can be seen under the nail as the white "half moon".

The main, hard part of the nail is called the body of the nail and this body lies on a nail bed of epidermal cells. Beneath this bed the dermis lies in ridges and the colour of the blood in the dermis can be seen through the nail body, giving it its pink colour. The side edges of the nail lie in grooves.

Nails do not all grow at the same rate. Scientists who have made observations of nail growth report that: (a) finger nails grow faster than toe nails; (b) nails on the longer digits grow faster than those on the shorter digits; (c) nails grow at different rates at different ages; (d) nails grow faster in summer than in winter.

V
HAIR

HAIR ON THE HEAD AND BODY

Look at the hair on your customer's head and face. There is fine, downy hair on her cheeks and longer, coarser hair in her eyelashes and eyebrows. On her scalp the hair is thickest and longest. If you look very closely you will probably see some finer, shorter hairs among the long, strong ones as well. The fine, downy hair is called vellus hair and it covers most of the body. There is no hair at all on the palms of the hands, the soles of the feet and the red part of the lips. Long, strong hair grows in women on the scalp, in eyebrows and eyelashes, under the arms and in the pubic region of the body. In men, as well as in these areas, it may grow over the chest, abdomen and back, and it grows in the beard region of the face. These long hairs are called terminal hairs, but there are almost always vellus hairs among them.

Your customer's hair may be naturally straight or naturally wavy or curly, or it may even be naturally "frizzy". All these variations from completely straight to exceedingly curly hair occur in nature and usually straight hair grows to a greater length than curly hair.

Look at the way the different hairs of your customer's head and face lie. The soft down on her face and the strong hairs of her eyebrows lie slantwise, so that they can be stroked in one direction. Each hair on her head also grows from the scalp at a slant but

all the hairs of her head do not lie in the same direction. They tend to grow in groups that may lie naturally in different directions from each other, and they may even grow in whorls which make parting the hair difficult. The hairs of her eyelashes, on the other hand, grow straight out of the skin and not at a slant.

Hair growth from the scalp is dense. It has been calculated that there are over three hundred hairs to the square centimetre on the scalp of a healthy person.

THE STRUCTURE OF A HAIR

The hair you are handling on the head of your customer is dead. Many of the hairs will still have a living, active root in the scalp and are still growing, but many others are resting and still others are being pushed out of the scalp by new hairs growing up beneath them. In any case that part of any hair which has emerged from the skin is made of dead, horny material called keratin. This part of the hair is called the shaft. If the hair has never been cut the end of the shaft will be pointed.

If you could take one hair from your customer's head, cut it across and take a very fine slice of it (as if you were cutting a slice of jam roll) and then look at this slice under a microscope you would see that it looked like this:

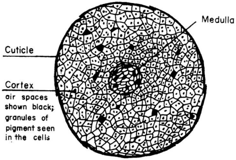


FIG. 21. *Cross section of a hair.*

A slice cut downwards through the middle of the hair would look like this:

FIG. 22. *Longitudinal section of a hair.*

On the outside is a thin rind called the cuticle. This is made up of one layer of overlapping scales (think of the tiles of a roof). The free edges of these scales point towards the end of the hair, away from the scalp. The edges of the scales may be plain or serrated. There is no colouring matter in the cuticle and it is translucent. When you give your customer's hair a colour-rinse, the colour does not penetrate further than the cuticle but remains around and between the scales. Thus it can be washed out easily.

If the scales of the cuticle fit tightly over each other the hair cannot be wetted easily. If by steam, or heat, or by the action of the chemicals, the scales are caused to open up, or to become softened, then the hair is more porous. Thus hair in a hot, steamy atmosphere, or hair which has been bleached is more porous than hair in a cool, dry atmosphere, or hair which has never been bleached.

Inside the cuticle is a wide band of tissue which makes up the main part of the hair. This is called the cortex. It is made of spindle-shaped cells which are dead and are composed of fine

fibres of an elastic, horny material cemented together. It is these fine fibres which are altered when hair is permanently waved. (See page 146.)

Between and within the horny fibres of the cortex are very small spaces filled with air. Hair can float for some time in water because of this air in the cortex. Yellow, brown or black colouring matter, called melanin is found in granules in the cells of the cortex. There are fewer granules in light-coloured hair than in darker hair. This pigment in hair can be altered by oxidation and this is what happens when you bleach hair. When you use a permanent dye on your customer's hair, it penetrates the cortex. This colour will not then wash out. (See page 152.)

In the centre of the hair shaft is a core called the medulla. In some hairs, especially fine ones, there is no medulla, in others it may not be continuous throughout the length of the hair shaft. However, all strong hairs growing from the adult human scalp have a medulla, although it may be so fine as to be seen only under a special microscope and may be interrupted at intervals along the shaft. Granules of melanin may occur in the cells of the medulla. There are long air spaces between and within the cells of the medulla and this air gives the hair a sheen because of the way it reflects light falling on the hair.

All hairs from human heads are not round in cross-section. Naturally straight hair tends to be round, but naturally wavy hair is usually oval, and naturally tightly curled hair often appears almost flat.

THE HAIR FOLLICLE

So far we have only discussed hair which has already grown out of the scalp; but every hair grows from a pit in the skin of the scalp. This pit is called a follicle; in a section of skin seen under a microscope it looks like the diagram Fig. 23.

The follicle is made by epidermal cells growing down into the dermis and the dermis surrounds it with a special cushion of dermal tissue. The bottom of the follicle is not flat. It is pushed

up from below into a pointed cone and in the space underneath it there is a mass of large loose cells and a generous supply of small blood vessels. This mass of cells and blood vessels is part of the dermis and it is known as the dermal papilla. So each hair grows from the epidermis and is nourished by the dermis.

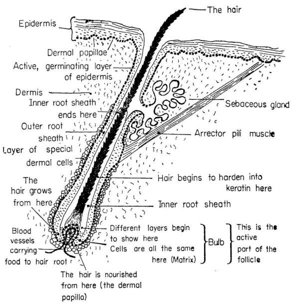


FIG. 23. *Diagram of a hair follicle. The blood vessels (except to the dermal papilla of the hair) and the nerves have been left out.*

You will see that about two-thirds of the way up the follicle there is an opening leading from a sebaceous gland. This gland makes a fatty substance called sebum which it pours into the follicle and from thence onto the skin of the scalp. This substance lubricates the hair shaft, keeps the skin of the scalp supple and slightly waterproof. Some authorities also say that it has anti-

septic properties. Large follicles often have two or three sebaceous glands opening into them. Follicles of hair from under the arms may also have large apocrine sweat glands attached to them. (See page 50.)

The dermis around the follicle is well supplied with blood vessels and with nerves. A strong, scalp hair has a number of small blood vessels supplying the dermal papilla under the hair root with nourishment and oxygen and there is also a network of small vessels surrounding the follicle, especially around the lower half of it. These provide nourishment and oxygen for the follicle itself as distinct from the hair root. It has been noticed that this supply of blood vessels is particularly dense when the hair is growing and the net of blood vessels around a large follicle is more elaborate than the net around a small follicle.

There is also a network of nerve fibres around the follicle and in this case fibres penetrate the outer root sheath, that is, they are actually inside the walls of the follicle. The nerve fibres come from all directions towards the hair follicle from networks of nerves in the dermis. When they reach the follicle they run in two directions. One group of fibres makes a kind of interwoven collar around the follicle just below the sebaceous gland. These are still in the dermis. A second group penetrate into the walls of the follicle, in the layer of epidermal cells which is known as the outer root sheath, and they run parallel to the hair shaft. This supply of nerve fibres makes each hair an extremely sensitive organ of touch. If you run your hand lightly up and down along the tips of the hairs of your forearm you will feel a definite wave of sensation under the skin and if you take a needle or a pencil tip and touch each hair separately near its tip, moving it about back and forth, you will feel a sensation surprisingly strong for such a fine, small organ.

The hair follicle is also supplied with a muscle called the arrector pili muscle. This name means a muscle which can pull the hair upright and this is what it does from time to time. It is joined to the sheath of dermal tissue round the follicle below the sebaceous gland on the side of the follicle towards which the hair slopes. The other end of the muscle is attached to the tissue

just below the epidermis. There is a blood supply to the muscle and nerve fibres also reach it. When the outer surface of the body feels cold, this muscle receives a message to contract. It does so and this pulls the hair upright and at the same time causes the skin to dimple at the surface. This is what we usually call goose flesh or goose pimples on our arms and legs. This pulling of the hair upright is an attempt by the body to capture a layer of air between the hairs and the skin to reduce the loss of heat from the body, but it is not successful in human beings because the hair is not thick enough over most of the body as it is in other hairy animals.

Although as a general rule each follicle contains one hair, it is not unusual, particularly on the back and scalp, for several follicles to grow so close to each other that they come together near the surface of the skin and share a common opening. It also happens, sometimes, in the beard region of a man's face, that one follicle will produce two hairs. In this case there are two dermal papillae and each hair is surrounded by its own inner root sheath.

GROWTH OF A HAIR

A hair begins to grow from a "root" in the base of the follicle. This "root" is a bulb of active cells from the epidermis fitted over and around a dermal papilla. The dermal papilla is a group of cells from the dermis underneath the follicle which are rich in blood vessels. and give nourishment to the hair bulb. The hair does not grow from the dermal papilla but it depends on the papilla for food without which it could not grow.

The lower part of the bulb is called the matrix and here the cells are constantly dividing into two, making new cells which are pushed upwards when still newer cells are made. In the matrix all the cells look alike but in the upper part of the bulb they begin to take on the shapes and positions in which they form the medulla, cortex and cuticle of the hair. They also form a protective sheath around the new hair called the inner root sheath.

This inner root sheath has an inside layer of scales which point downwards. You remember that the scales on the outside of the hair point upwards towards the tip of the hair, so you will understand that the scales of the hair and the scales of the inner root sheath interlock with each other and this holds the hair firmly in the follicle.

In the upper part of the bulb granules of colouring matter can already be seen.

The walls of the follicle make what is known as the outer root sheath and outside the follicle is a layer of special cells from the dermis as an extra kind of protective sheath between the follicle and the rest of the dermis in which it is sunk.

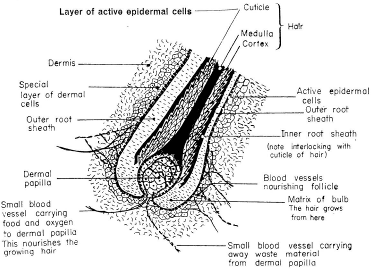


FIG. 24. *Diagram of bulb and dermal papilla of the follicle.*

As the newly formed hair grows on upwards it begins to harden and to turn into the horny material keratin. By the time it reaches about one-third of the way from the matrix to the top

of the follicle it is hard and dead. As new cells are continually forming in the matrix and being pushed upwards into the upper part of the bulb, the hair is pushed further and further up the follicle.

About two-thirds of the way up the follicle the inner root sheath disappears and the naked hair continues to be pushed upwards until it emerges from the top of the follicle and can be seen from outside. It continues to grow until it has reached the usual length of a hair.

All hairs grow in the same way, on whatever part of the skin they may be, but of course they do not all grow to the same length. Hairs on the arms are much shorter than hairs on the scalp.

When the growing hair has reached its maximum length it stops growing and enters a resting period. During this time changes take place in the root of the hair. The bulb breaks down and the lower end of the hair is no longer attached to the base of the follicle. The end of the hair is now described as a club and it has around it a little of the inner root sheath and a thick sac of the outer root sheath. A thick strand of this outer sheath remains in touch with the dermal papilla, which now has no bulb around it and which is more compact and has fewer blood vessels. This strand is a root germ from which a new hair can grow. The whole follicle grows shorter and more shrivelled.

After a time of resting, the root germ begins to grow downwards and forms a new bulb round the dermal papilla. The whole follicle grows downwards until it is as long as when the last hair was growing in it. The cells of the dermal papilla enlarge and more blood vessels develop in it. A new hair begins to grow from the bulb and as it grows upwards it pushes out the old hair

You will find that textbooks sometimes say that a follicle in which there is an actively growing hair is in "anagen"; a resting follicle is in "telogen"; and one which is changing from the one state to the other is in "catagen".

These periods of growth and rest vary from one follicle to another in length, but in the scalp and beard the periods of rest are short compared with those in other parts of the body. If a club hair is plucked out instead of being allowed to fall out a

new hair begins to grow at once. If a new hair which is still growing is plucked out, however, a great deal of the lower part of the follicle is torn out with it and it takes a very long time before the follicle recovers enough to begin growing a new hair. Cutting a hair seems to have no effect on the rate of growth.

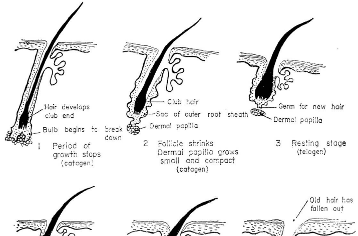


FIG. 25. *Rest and growth in a hair follicle*

The life of a hair varies according to where on the body it grows. It naturally takes much longer for a long scalp hair to reach its maximum length so it has been calculated that a hair from the scalp may live for several years. Shorter hairs may live

less than one year. It has been observed, however, that long scalp hairs grow at a faster rate than shorter, finer hairs.

NOURISHMENT OF A HAIR

The matrix of the root bulb is a very active group of cells. They need constant nourishment. They need protein to build new cells and they need carbohydrate and oxygen to provide energy for their work. This nourishment they receive from the blood vessels in the dermal papilla. The food your customer eats is turned by her digestive organs into the kind of nourishment her hair root needs and the blood carries this nourishment to the dermal papilla. Nourishing fluid seeps out of the tiny blood vessels in the papilla and bathes the cells of the hair bulb around it. They absorb the nourishment and release into the fluid their waste matter. The fluid then drains away carrying the waste material with it. This goes on all the time all over the skin so that the roots of all growing hairs have a continuous stream of food material and oxygen brought to them. If your customer stopped eating, the reserves of food, stored in her body, would be used up and she would eventually die. Surprisingly enough, her hair would go on growing, but more slowly, right up to the time of death. The only connection which has been shown betweendiet and growth of hair is in the case of gross vitamin deficiency over a long period.

DIFFERENCES IN HAIR GROWTH

A hair follicle can give rise during its life to several kinds of hairs. Before birth the human foetus is covered with fine hair. This is called lanugo hair. It grows in the same way as other hair, but there are no blood vessels in the dermal papilla. Nourishment seeps in from blood vessels further away.

This hair is usually shed before the child is born, and the follicles then produce stronger and longer vellus hair after birth. This is still downy and soft, but it is less fine than lanugo hair. There are now small blood vessels in the dermal papilla. Shortly after birth the follicles of the head and eyebrows begin to pro-

duce coarser terminal hair, and the dermal papillae of the follicles are richly provided with blood vessels. At puberty follicles in the armpits and in the pubic region and, in men, in the beard area begin also to produce coarse, strong hair.

When a man becomes bald the follicles of the scalp cease to produce terminal hairs but return to producing very fine lanugo hairs. In this case the dermal papillae are no longer supplied with blood vessels. In an ageing bald man the sebaceous glands grow very large and are well supplied with blood vessels.

Old women sometimes begin to grow a few long, coarse hairs in the beard and moustache region of the face. They can be shaved off without fear that this will increase their coarseness.

Loss of colouring in hair usually occurs as we grow older, but sometimes fairly young people have grey hair, and old people do not lose their hair colour. It is not clear why the matrix of the hair bulb ceases to produce melanin, but it is certainly determined by heredity. In old age some of the greying of hair is due to the appearance of bubbles of air in the hair shaft coupled with a reduction in melanin production.

FUNCTIONS OF HAIR

Finally, we should remember the usefulness of hair. Hairy animals are kept warm by their hair because air is held in it and this slows up the loss of body heat. Man does not grow enough hair for this and has learned to wear clothes instead. Human beings as a rule have more fat beneath the skin than other hairy animals. This helps to keep the heat in, but is no substitute for hair.

Because of its nerve supply a hair is a sensitive organ of touch. The fewer the hairs there are in any region the more delicately each hair appears to register its position; this is because each one can be stimulated separately. You can test this out by comparing the sensitiveness of your individual arm and scalp hairs.

Hair round the eyes serves two very useful purposes. The eyebrows stop too much sweat from the forehead rolling into the eyes, the eyelashes protect the eyes from dust and dirt. Hairs in the nose filter dust and particles of dirt from the air breathed in.

VI
MEASURING IN SCIENCE

Much of the time of a scientist is spent measuring objects or events. Once the record is made the measurement is written down in order that it may be checked if need be, later.

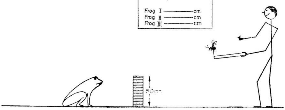


Fig. 26.

The record made is not written down in pounds, feet or cubic inches. This is the ordinary English method which is very confusing and may soon be changed. The scientist writes down his records in one of the following *units*.

Length—centimetres, cm; metres, m (100 cm).

Weight—grammes, g; kilogrammes, kg (1000 g).

Volume—(of liquids) millilitres, ml; litres, l (1000 ml), a millilitre is the same as a cubic centimetre (cc), when measuring solids it is written cm^3.

Time—seconds, sec; minutes, min.

The number in his records are not written as fractions (e.g. $2\frac{1}{2}$). The records are all kept in the *decimal* system (e.g. $2\frac{1}{2}=2\cdot5$).

Changing fractions into decimals is a simple operation.

FIG. 27.

EXAMPLE What is $\frac{1}{2}$ and $\frac{3}{4}$ as a decimal?

Divide the bottom figure into the top figure. Before you write down the answer put down a dot or point.

$\frac{1}{2} =$ 2 into 1 does not go, put down 0· and try dividing into 10

2 into 10 goes 5

Thus the decimal of $\frac{1}{2}$ is $0\cdot5$

$\frac{3}{4} =$ 4 into 3 does not go, put down 0· and try dividing into 30

4 into 30 goes 7 (with 2 left over)

4 into 2 does not go, add 0 and try dividing into 20

4 into 20 goes 5 (put this figure after the 7)

Thus the decimal of $\frac{3}{4}$ is $0\cdot75$

EXERCISE. *Change the following fractions into decimals.*

2/3 4/5 6/8 2/9 4/12 1/6

The scientist does not write down $2\frac{1}{2}$ cm or $4\frac{3}{4}$ ml; he writes down $2\cdot5$ cm or $4\cdot75$ ml.

EXERCISE—*Measuring length.*

Take a series of solid objects and using a centimetre rule measure accurately the length of each surface. Record your results and compare them with other students measuring the same objects.

EXERCISE—*Using a chemical balance*

Before using the balance check to see that it is level on the bench. This is usually done by adjusting the screw-type legs beneath the balance. Also check to see that the needle points to zero when the scale pans are raised empty.

Onto the right hand scale pan of the balance place a 1 g weight. Onto the left pan place a small piece of plasticine. Raise the scale pans for a time to see if they are balanced. This you can tell by the movement of the swinging needle. Lower the scale pans and take away small pieces of the plasticine until it eventually balances the 1 g weight.

Compare your result with those of other students. Check each others weights.

EXERCISE—*Using a measuring cylinder to find the volume of an object*

Pour some water into a 100 ml measuring cylinder until the bottom level of the water curve (*meniscus*) touches the 50 ml mark.

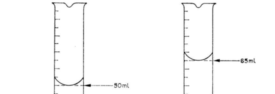


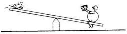
FIG. 28. *The meniscus.*

Into the cylinder gently lower various sized lumps of plasticine and note the level to which the water meniscus rises. The amount the water has risen up the cylinder is equal to the volume in cubic centimetres of the plasticine. Compare your results with other students.

VII
PROPERTIES OF MATTER

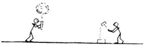
SCIENCE is concerned with matter and its properties. Science is not concerned with "things" non-material.

(a) Matter is any object that occupies space and has weight.



(a)

(b) Matter cannot be created nor destroyed.



(b)

(c) The smallest part of matter is the *atom*.

(c)

(d) The smallest particle of matter than can exist independently is the *molecule*.

Groups of atoms make up molecules.

FIG. 29.

e.g.
Atom of oxygen—O Molecule of oxygen O—O (O_2)
Atom of hydrogen—H
Molecule of hydrogen H—H (H_2)

(e) Molecules in matter are always on the move.
(f) Matter can exist in three forms—solid, liquid and gas.

THE DIFFERENCE BETWEEN SOLIDS, LIQUIDS AND GASES IN TERMS OF MOLECULES

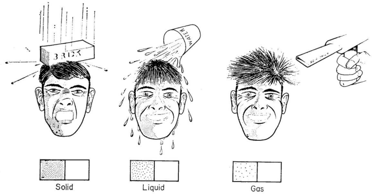


FIG. 30. *Density and molecular packing.*

Solids

The molecules in solids are closely packed together; they are very dense. Solids are said to have a greater *density* than liquids or gases.

Liquids

The molecules in liquids are spaced further apart than those in solids; they are thus usually less dense than solids.

Gases

The molecules in gases are very widely spaced; they therefore have a lower density than either solids or liquids.

Finding the Density of Matter

Solids, liquids and gases have different densities because the molecules from which they are constructed are packed together differently.

A solid may differ from another solid *in terms of density*, for example brass is more dense than aluminium. A liquid may differ from another liquid *in terms of density*, for example water is more dense than paraffin. In order to determine the density of a substance it is necessary to perform two operations:

(a) Find the *weight* of the substance in grammes (g)
(b) Find the *volume* of the same substance in cubic centimetres (cm^3) or millilitres (ml).

If the weight is divided by the volume $\left(\frac{W}{V}\right)$ then the resulting figure is the density of that substance.

EXAMPLE. 10 g of water have a volume of 10 ml

$$\text{Therefore density } \frac{10\text{ g}}{10\text{ ml}} = 1\text{ g/ml}$$

Water has a density of 1 g per ml.

THE MEANING OF RELATIVE DENSITY (SPECIFIC GRAVITY)

If 1 cm^3 of many different substances are weighed, they are all seen to have different weights.

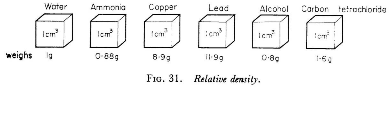


FIG. 31. *Relative density*.

From the above diagram it is seen that copper is 8·9 times as dense as water. Aluminium is 2·7 times as dense as water. This comparison of the weights of 1 cm^3 of a substance with the weight of 1 ml of water is known as the *Relative Density* or *Specific Gravity.*

Thus the specific gravity of lead is 11·9, copper 8·9, ammonia solution 0·88, etc.

Finding the Specific Gravity of a Liquid using a Hydrometer

When solids float they do so at different depths in liquids of different specific gravities.

For example, a pencil floated in water will sink to a different level from the level to which it will sink in methylated spirit or carbon tetrachloride (cleaning fluid).

The hydrometer is a glass tube which will sink to different levels in different liquids. The specific gravity of that liquid is read off from the standard scale on the side of the glass tube.

The hydrometer is standardized so that it will float to a pre-recorded mark on all occasions in the same liquid.

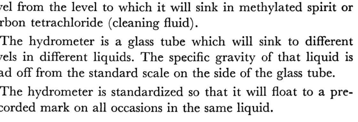


FIG. 32A. *Hydrometers and their use.*

Experiment. Making a simple hydrometer

A test tube is floated in water until the water reaches half way up the tube; this is achieved by putting pieces of plasticine into the tube as weights. The level to which the tube floats in water is marked S.G. = 1·00. The process is repeated for methylated spirits and other liquids of interest, marking the specific gravity on the side of the tube.

This hydrometer may now be used to test various liquids for their approximate specific gravity.

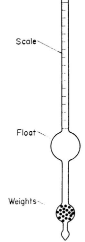


FIG. 32B. *The hydrometers.*

Applications of this Knowledge in the Salon

A brown bottle of ammonia solution, sometimes labelled "Ammonia fort S.G. = 0·88" may be somewhat of a mystery. "Ammonia fort" means strong ammonia. This strong ammonia has a specific gravity of 0·88. This of course means that it is less dense than water which has a density of 1·0 and a hydrometer will float in it up to the 0·88 mark.

VIII
EFFECTS OF HEAT ON MATTER

HEAT is a form of energy measured in *calories*; a calorie is the amount of heat required to raise the temperature of 1 g of water 1°C. Heat may also be recorded in terms of the *British Thermal Unit* (B.t.u.); this is the amount of heat required to raise the temperature of 1 lb of water through 1°F.

10,000 B.t.u. is called the *Therm*

When heat is applied to matter the molecules which make up that matter tend to increase the speed of their movement. This continued heating may result in the matter *changing its state* and *expanding*.

CHANGE OF STATE

When matter is heated for any length of time it may change its form or state.

EXAMPLE. Ice melts to become water when heated. If heating is continued the water changes into water vapour. Water then may exist in three states.

Ice $\xrightarrow{\text{heat}}$	water $\xrightarrow{\text{heat}}$	steam (water vapour)
(solid)	(liquid	(gas)

Matter then exists in three states—solid, liquid and gas.

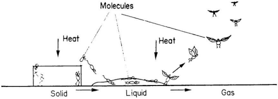


FIG. 33.

Experiments to demonstrate Change of State

(a) Beeswax or Lanolin, when heated in a test tube will liquify, that is it will melt. On further heating the liquid will vaporize, that is it will evaporate. (Careful—vapour inflammable.)

(b) Rubber, when heated for a length of time will melt and eventually vaporize.

(c) Metals such as lead will melt when heated and at very high temperatures will vaporize.

(d) Overheating due to excessive electrical current will cause rubber or plastic coverings to melt. Also, too much current will cause a metal fuse wire to melt.

EXPANSION AND CONTRACTION

When matter is heated it usually *expands*, that is it increases its size owing to the increased movement of molecules. When matter

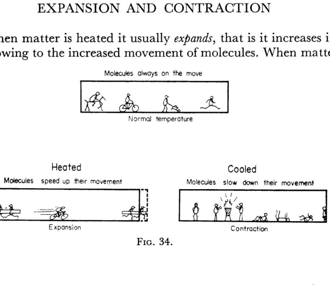


FIG. 34.

cools down the molecules return to their original condition and the object *contracts* to its original size.

Solids, liquids and gases all expand on heating.

Note this exception to the rule: When water is cooled to 0°C then it expands. This expansion causes the cracking of water pipes when the water freezes. When the temperature of water is increased from 0°C to 4°C, the water contracts.

Experiments to demonstrate the Expansion of Solids

(a) A metal ball hanging on a chain will *just* pass through a metal ring when at room temperature.

When the ball is heated it *expands* and will not pass through the metal ring.

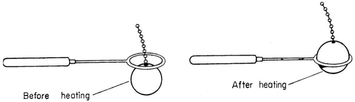


FIG. 35. *Ball and ring experiment.*

(b) Two different pieces of metal are closely rivetted together. One of the metals expands more rapidly than the other on heating. When this *bimetallic* bar is heated it will curl over because of the different expansion rates.

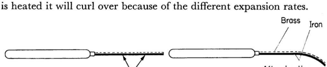


FIG. 36. *The bimetallic strip.*

(c) A steel rod is fixed firmly to a block of wood at one end; the other end is laid across a cylinder of metal which has a pointer fixed to it. When the steel rod is heated it expands. It is unable to expand in both directions because one end is fixed. The pointer rotates showing expansion to be taking place.

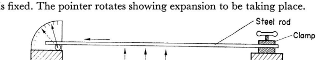


FIG. 37. *The expanding rod.*

Experiments to demonstrate the Expansion of Liquids

(a) A conical flask is filled with water. A rubber bung with a glass tube fitted is firmly pushed into the neck of the flask. When the water in the flask is heated, it expands. The expansion of the water is seen because the water level in the tube rises.

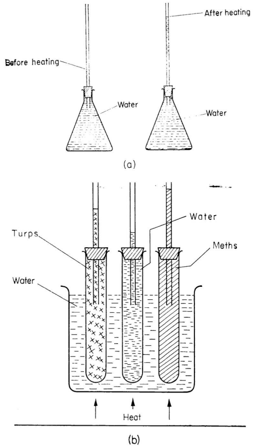


FIG. 38. *Expansion of liquids.*

(b) Three boiling tubes containing three different liquids have rubber bungs with glass tubes fitted, firmly pushed into their necks. These boiling tubes are all supported in a large beaker of water.

The beaker of water is heated by means of a Bunsen flame in an even manner. The three different liquids are seen to expand up the tubes at different rates despite the same source of heat.

Experiment to demonstrate the Expansion of Gases

A glass capillary tube with a bulb at one end has a small droplet of coloured water put into the neck. When the air in the bulb of the tube is heated by the hand, then that air expands and forces the coloured water marker up the stem of the tube.

This type of apparatus is often called an *Air Thermometer*.

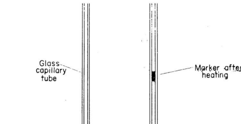


FIG. 39. *Air thermometer.*

Application of the Principle of Expansion in Hairdressing

(a) *The Thermometer.* The thermometer is based upon the principle that matter expands when heated and contracts on

cooling. Most thermomenters use mercury because it expands evenly over a range of temperatures. There are two types of thermometer scale in common use.

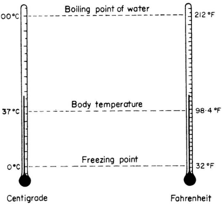


FIG. 40. *Thermometers.*

The Fahrenheit Thermometer is commonly used for domestic purposes and by the doctor.

Freezing point	32°F
Body temperature	98·4°F
Boiling point of water	212°F

The Centigrade Thermometer is commonly used all over the continent of Europe and by all scientific workers.

Freezing point	0°C
Body temperature	37°C
Boiling point of water	100°C

Converting from one scale to another involves a simple piece of arithmetic.

Centigrade to Fahrenheit:

Multiply by 9, divide by 5, add 32.

e.g. 50°C $\times$ 9 $=$ 450 $\div$ 5 $=$ 90 $+$ 32 $=$ 122°F.

Fahrenheit to Centigrade:
Subtract 32, multiply by 5, divide by 9.
e.g. 122°F — 32 = 90 × 5 = 450 ÷ 9 = 50°C.

(b) *The Thermostat.* The thermostat is a device for regulating temperatures at a set value. The thermostat is based upon the principle of expansion and contraction.

The thermostat is used to regulate the temperature of the air which is blown across the hair in the hairdrier. Not all hairdriers are thermostatically controlled. The temperature is controlled by the client herself.

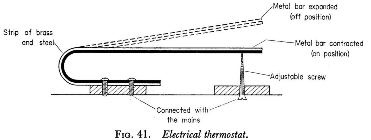


FIG. 41. *Electrical thermostat.*

The bimetallic strip of brass and steel curves upwards when it becomes hot as a result of different expansion rates of the metals. When the strip curls upwards it breaks contact with the mains electricity which enters through the adjustable platinum screw. The thermostat is controlled by altering the position of the adjustable screw.

MELTING, EVAPORATION AND BOILING

Melting is said to take place when a solid changes into a liquid as a result of heating.

e.g. Ice $\xrightarrow{\text{heat}}$ water

Fat $\xrightarrow{\text{heat}}$ oil

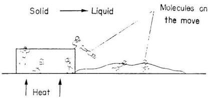


FIG. 42. *Melting.*

Evaporation is said to take place when a liquid changes into a vapour or gas. Evaporation takes place at liquid surfaces, the liquid molecules change their state and become vapour molecules. This process takes place at most temperatures.

$$\text{e.g. Water} \xrightarrow{\text{heat}} \text{water vapour}$$
$$\text{Alcohol} \xrightarrow{\text{heat}} \text{alcohol vapour}$$

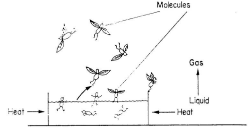


FIG. 43. *Evaporation.*

Boiling takes place at a definite temperature (e.g. water boils at 100°C or 212°F if pure). Boiling affects the whole liquid. When boiling is taking place liquid molecules leave the liquid surface rapidly as vapour molecules.

Evaporation takes place rapidly at the boiling point.

Examples of Melting and Evaporation in Hairdressing

(a) Scalp and face creams are made from fats and oils. They must *melt* on coming into contact with the skin. Thus creams, lipsticks, etc. must be made from fats that melt at body temperature.

(b) When the hair is being dried under the hairdrier the principle of *evaporation* is in operation. The heated air raises the temperature of the water on the hair changing it to water vapour. Evaporation is the natural process whereby the body surface is cooled. Perspiration is heated on the skin by the body tissues. When the perspiration changes to vapour a cooling effect is noted on the skin.

Hair lacquers are dissolved in highly volatile (rapidly evaporating) spirits, so that they evaporate on the hair leaving behind the lacquer.

Perfumes are highly volatile essential oils. These oils change to vapours rapidly, thus their presence in the air. The vapours of perfumes *diffuse* throughout the air because it is the tendency of gases to fill the largest available space.

IX
HOW HEAT TRAVELS

HEAT travels through matter in three ways:

(a) Conduction—through solid objects.
(b) Convection—through liquids and gases.
(c) Radiation—through gases and space.

Experiment to demonstrate Conduction

FIG. 44. *Conduction of heat in solids.*

Three rods of metal, steel, copper and aluminium are fixed over a flame so that each has a small section of their length in the flame. At the other end of each rod a piece of lead shot is fixed by means of vaseline or wax.

The heat travels from the flame along the rods until it reaches the wax or vaseline, this melts and the lead shot falls off. The first lead shot to fall off is on the copper rod which is thus shown to be the best conductor of heat.

Experiments to demonstrate Convection
Convection in liquids is shown in the following experiment.

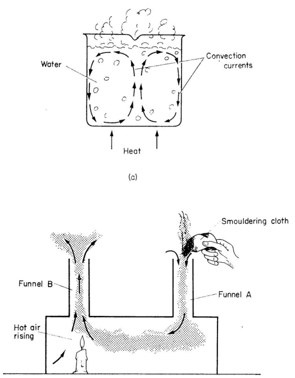


Fig. 45. *Convection currents in water and air.*

A beaker of water has a small quantity of coloured sawdust added to it. As the water is heated the sawdust rises with the less dense water currents. As the water cools at the surface the sawdust falls to the bottom again. This circular movement is known as a *convection current*. The Domestic hot-water system uses this principle.

Convection in gases is shown by the "Convection Tunnel" experiment as follows.

A piece of smouldering cloth is held over funnel A in the apparatus shown on page 83.

Beneath the funnel B is a burning candle. The hot air above this candle rises and leaves the tunnel. As this air leaves the tunnel it draws more in at funnel A; this is shown by the smoke being drawn into the funnel to take the place of the air leaving at B. This circular movement is known as a *convection current.*

Experiment to demonstrate Radiation and Absorption of Heat

Heat travels in straight lines. Heat reaches us from the sun by radiation. Radiation and absorption of heat may be shown in the following way.

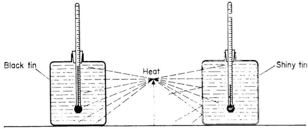


FIG. 46. *Radiation and absorption.*

Two tins are placed at equal distances from a Bunsen burner flame. Both tins are filled with water. One of the tins has a shiny polished outside, the other tin is sooty black. Into both tins a thermometer is placed.

The heat *radiated* from the flame will cause an increase of temperature of the water in both of the tins. The increase in temperature is noted to be higher in the black tin, this being because black *absorbs* radiated heat. The shiny tin *reflects* most of the radiated heat.

This then shows that heat is radiated through the air and that surfaces differ n their ability to absorb or reflect radiated heat.

Examples of Conduction, Convection and Radiation in the Salon

Conduction is seen to take place along the metal handles of any apparatus that is liable to get hot. To prevent burns, handles are usually insulated with asbestos or plastic e.g. handles of curling irons and metal tea pots.

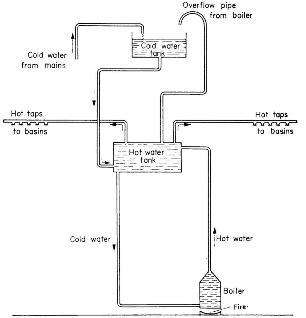


FIG. 47. *The domestic hot water system.*

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Convection

1. *Draughts* are caused by convection. The heat rising to the ceiling from a fire or radiator draws in air from cracks in doors or windows to replace the moving air. The clean ceiling of a salon will soon become dirty if the tops of radiators or any other heater are not covered. The rising hot air tends to take dirt particles up with it. Draughts in the salon must be avoided.

2. The *Domestic hot water system* is based upon convection currents in water.

The boiler is usually situated in a low position in the basement, and the water which is heated becomes less dense and rises up the pipes to the place of need. The supply of fresh cold water from the mains is usually found in the roof tank. (See Fig. 47.)

Radiation

The electric fire radiates out heat into the atmosphere.

Electric light bulbs also radiate out a fair amount of heat and should not be placed in close contact with imflammable materials.

Heat is reflected from light coloured materials, thus protective clothing for the staff and clients are best in the lighter shades.

X
LIGHT

MANY hot objects not only give out heat, they also give out light. Luminous objects make other things visible by throwing light upon then.

1. Light travels in straight lines (like heat).

2. Light travels at 186,000 miles per second. Nothing can exceed the speed of light. Radio waves travel at the same speed.

3. Light may be reflected from flat surfaces (like heat).

4. Light rays are bent when entering water or glass.

5. White light may be split up into many colours when passed through a *prism*. These different colours are called the *spectrum*.

Experiment. To demonstrate that white light may be split up into a spectrum of colours.

A beam of ordinary light is allowed to strike one face of a glass prism. A white screen is placed on the other side of the prism. A band of colours is produced on the white screen—this is called the *spectrum* (Red, Orange, Yellow, Green, Blue, Indigo, Violet). (See Fig. 48.)

Experiment. To demonstrate that when the spectrum colours are added together white light is produced.

A cardboard disc with the seven colours of the spectrum painted on it in sectors is fixed to the spindle of an electric motor. When the disc spins at high speed the colours disappear and the card appears white.

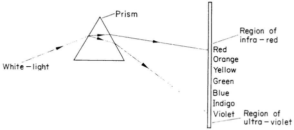


FIG. 48. *The spectrum.*

Common Examples of the Spectrum

1. Raindrops act as small prisms when the sun is shining and split up white light to produce the rainbow.
2. Oil floating on water appears many colours; the oil droplets act as prisms splitting up the light.
3. The edge of a mirror shows a prism-like activity in splitting up white light.
4. Diamonds and cut-glass "glitter" due to the splitting up of white light.

Why Objects have Different Colours

There are certain pigments in the world which absorb all the colours of the spectrum except one, which is reflected. An object is coloured if it contains such a pigment.

A red object is red because it contains a pigment which absorbs all the other colours of white light, but reflects red. Black objects contain no pigment—they absorb all the white light and reflect no colour.

Application in Hairdressing

(a) *Dyeing* a person's hair is putting into it a pigment which will reflect the required coloured light of the spectrum.

(b) All colours are combinations of the basic seven colours.

Infra-red and Ultra-violet Radiations

At each end of the spectrum there are rays which are invisible. *Below the red* (infra-red) are rays such as heat rays. *Above the violet* (ultra-violet) are rays such as reach us from the sun. These rays like light are measured in "wave-lengths".

Infra-red rays. This is a longer wave-length than visible light and is *heat.*

It has a soothing effect on the body and promotes blood flow. It stimulates sweat glands to increase their flow.

Ultra-violet rays. This is a shorter wave-length than visible light. It is usually invisible—but in ultra-violet lamps it often appears violet due to mixing with visible violet.

This "light" produces skin burns and causes pigment changes in the skin (sun tan). It has a stimulating and tonic effect on the skin. It is dangerous to the eyes, causing permanent damage to the retina.

Applications in Hairdressing

The ultra-violet lamp is used for removing skin blemishes, acne, etc. It has an antibacterial effect on the skin. It must only be used on medical advice and under qualified supervision.

XI
HEATING AND VENTILATION IN THE SALON

THE practical application of knowledge about heat, its effects on matter and how it travels is involved in the heating and ventilation of salons.

SOME GENERAL CONSIDERATIONS

When we talk about heating in relation to a salon we mean space heating, that is, keeping the salon warm in cold weather, and water heating, which must go on all the year round.

It is as well to remember some elementary facts.

1. There must be a source of heat to warm the air and the water by conduction or to warm the surfaces of the salon (floor, walls and furniture) by radiation. Fuel is needed to produce this heat.
2. Heat can be carried by air and water some distance from the source of heat by convection or by pressure from a pump or fan.
3. Heat exchange goes on all the time. This means that heat is lost from warmer objects to cooler ones. So warm air, as it circulates through a room, is all the time giving up its heat to the cooler objects it touches and becoming itself cooler and denser.

In the same way, if hot water tanks or cylinders are not lagged, they will lose heat to objects around them and especially because they are made of metal, which gives off heat easily. Lagging slows down this loss of heat by (a) holding a layer of air around the cylinder. This acts as an insulator because air is a poor conductor of heat; (b) surrounding the cylinder with a thick layer of material which does not absorb or give off heat easily.

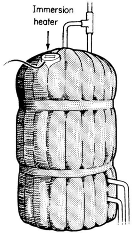


FIG. 49. *Lagging.*

A hairdressing business has special problems of heating.

(a) As a rule it uses only part of a building used for other purposes as well. It may not be able to use the form of heating most economical for its needs but may have to share with other tenants.

(b) not all the rooms used in the business need to be at the same temperature as each other.

(c) The main rooms must be kept at a comfortable temperature for people with wet heads.

(d) these rooms are likely to become warmer and more humid as the day goes on because of the work carried on in them.

(e) it needs an abundant supply of hot water.

The decision as to which type of heating is to be used will depend on (a) the size of the salon (if long pipes have to be used, heat is lost); (b) the number of customers it serves each day; (c) the type of building it is in (large modern business block, small shop, room in old premises, part of a department store); (d) where in the building the salon is situated (basement, ground floor or upper floor); (e) facilities available in the town (there may be no gas, or even no electricity in some country areas); (f) regulations and bye-laws in the town (it may be in a Smoke Control Area); (g) cost of fuel in the area; (h) convenience of operating.

It may not be economical to use one form of heating for both space and water heating, since so much hot water is needed all the year round.

SPACE HEATING IN SALONS

Keeping the salon itself warm is not a great problem. So much heat is given off by the equipment used during the day that the temperature of the room after some time is high enough for comfort in cold weather and may prove too high in summer. But for the sake of the staff and early customers, the salon will have to be heated on cold mornings at opening time and the reception area, staff room, offices and lavatories may need to be warmed all day. A comfortable temperature for the salon is about 65°F. It is important to be able to adjust the temperature of the salon easily, and thermostatic control of heating is a great advantage.

A large hairdressing business may use a form of central heating in which the temperature of each room can be controlled separately, but the small salon is likely to use a simpler means of heating.

1. *Central Heating* is carried out by circulating hot water, or steam, or hot air through a building from a centrally placed source of heat. The fuel used to provide the heat can be gas, oil or solid fuel.

The circulation of hot water may be on the same principle as that shown on page 85, but the water for space heating will pass through "radiators" in each room before going back to the boiler. The word "radiator" is not an accurate term, because the pipes or panels forming a radiator heat the room by convection rather than by radiation.

In modern buildings it is more usual to have a pump near the boiler to force the hot water quickly through the pipes instead of depending on convection and gravity. In this case the pipes can be of smaller diameter and the radiators smaller and neater so that they do not obtrude into the decoration of the salon.

Sometimes, instead of radiators, hot water pipes are placed under the floor or behind panels let into walls and ceiling. These panels are painted to fit in with the scheme of decoration and so are unnoticeable.

Sometimes steam is circulated through the pipes instead of hot water, but this tends to make the pipes and radiators too hot for comfort and safety.

If hot air is used to warm the salon it is heated at a central source of heat and blown by a fan through ducts which open into the various rooms.

2. *Some Fixed Forms of Heating*, less elaborate than central heating, are used by many salons and for these electricity is the most usual fuel. Gas is sometimes used. Solid fuel stoves or fires are rare in hairdressing salons in Britain.

(a) *Electric under-floor heating* is popular in some modern salons. It is carried out by sinking electric elements in the concrete screed under the floor. It is expensive to instal, especially in older buildings, but economical to operate because it is thermostatically controlled and can often be paid for at lower rates than other forms of electric heating. On the other hand some hairdressers complain that they tire more easily on warm floors and that their feet swell and ache.

(b) *Tubular heaters* are unobtrusive and efficient in giving an even warmth. They consist of electric elements in metal tubes which are finished in a dull colour (because this gives off heat

better than a light or shiny finish) and they are usually placed on the wall at about skirting-board level. They do not become too hot to touch safely.

(c) *Electric panel heaters* can be fixed to walls or ceilings. They are made of metal or toughened glass and have an insulated electric element enclosed in them. They can be painted to match the scheme of decoration. They are usually thermostatically controlled.

(d) *Electric fan heaters* are convenient if they are placed in the right position. They consist of a metal case in which is an electric element and a fan. Air is warmed by the element and driven out of a grille by the fan. They can be hung on the wall or placed on the floor, but is is important to place them carefully. A cool draught may be felt behind them as the air is being drawn into the case. If they are placed so that the warm air is directed at head level they can cause headaches and discomfort to the hairdressing staff, but if the air is directed at foot level the warmth rises pleasantly. They are useful in hot weather because the heating element can be switched off and the fan left on to circulate air. They are thermostatically controlled.

(e) *Gas fires and gas convection fires* are occasionally used in small salons. They must be installed in a flue.

3. *Some Portable Forms of Heating* are useful in salons of moderate size. Here electricity and paraffin (kerosene) are the most usual fuels.

(a) *Electric convector heaters* are most useful because they are light to handle, economical to run and safe to use. Air enters a free standing metal case at the bottom, is warmed by a heating element, rises and escapes by a grille at the top. If several of these heaters are used at various points in a moderately sized salon a good background heat is obtained throughout the room. There are several different heat settings and the case itself does not grow hot to the touch. Towels must not be draped over a convector heater to dry because the grille is then covered, the heated air cannot escape, and the system breaks down.

(b) *Paraffin convector heaters* act in the same way as electric convector heaters but in this case the fuel is oil and not electricity. They are fitted with a container for oil which is gradually drawn up into a wick and turned by the heat into vapour. The flame seen is blue because the vapour is mixed with air as it burns. Cool air is drawn in at the bottom of the case, heated by the flame, and escapes into the room through a grille near

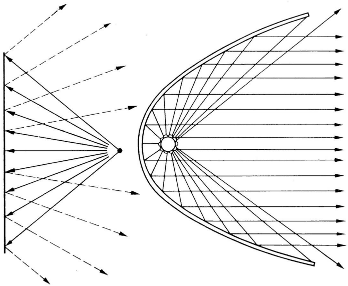


FIG. 50. *Reflection from plane and curved surfaces.*

the top. They are not as convenient as electric convector heaters because they have to be moved with more care and the oil container must be refuelled at intervals. Sometimes, if the flame is not adjusted carefully, they give off an unpleasant smell. They give off considerable amounts of water vapour which adds to the moisture in the air. They are distinct fire hazards.

(c) *Oil-filled electric radiators.* These are flat, metal containers which look like wall radiators. They are filled with compressed oil. An electric element heats the oil, which warms the container, and this warms the air around it. The oil does not have to be changed but is sealed in. They are usually thermostatically controlled and can be moved from place to place.
(d) *Electric radiant fires* give heat quickly and can be placed wherever they are needed. They depend on heat from an element (resistance wire) being reflected from a highly polished, curved reflector. If the reflector were straight the heat would be dispersed, because heat rays are reflected from a surface at the same angle as that at which they strike it.
A curved reflector directs the heat forward. The most efficient reflector is curved like the one in Fig. 50 and is known as a parabolic reflector.
These fires must, by law, be fitted with a wire guard.

Although portable electric fires are convenient they are not altogether safe in an open salon where the busy hairdresser may trip over the flex and where wisps of cotton wool and hair are constantly falling from the working level. They may be used with more safety in cubicles, in the reception area and in the staff room.

METHODS OF WATER HEATING IN SALONS

1. Mention has already been made of a *hot-water system based on convection currents* in water (page 86). A boiler is heated by solid fuel or gas. The water heated in the boiler rises and enters a large storage tank or cylinder from whence it can be drawn off to the basins (see Fig 47, page 85). The cylinder is well lagged to prevent loss of heat by radiation. There are several variations of this method of water heating. For instance there may be a hot water tank as well as the cylinder

2. Modern large salons often use what is known as "*thermal storage*". This method uses large tanks or cylinders, well lagged,

in which water is heated by electricity at night, when electricity costs less than during business hours, and the stored hot water is drawn off during the day.

3. *Electric immersion heaters* are popular in salons of moderate size. A lagged tank or cylinder of water has one, or sometimes two, insulated electric elements fitted into it. These heat the water and keep it at whatever temperature is desired by thermostatic control. (See Fig. 49.)

4. In smaller salons *gas geysers* or instant water heaters are often used. They are convenient because they heat water rapidly as it flows from the mains and they have an efficient temperature control so that water at the desired temperature can be used. They are economical because the gas is only burned when the water is actually flowing, except that there is a small pilot light. The device which acts in these heaters is described on page 134. This type of heater can supply several basins close together and in this case it is called a multipoint heater.

5. *Electric instant water heaters* can also be used, but in these the flow of water is usually slower than in gas geysers. This is not always a disadvantage in a salon and this type of heater is sometimes used in districts where there is no gas.

6. *Small storage heaters* over basins can be used with gas or electricity. They are not as efficient for hairdressers as instant heaters because time must be allowed for heating a fresh supply of water in the tank if the hot water is all drawn off at once.

VENTILATION OF THE SALON

It is necessary to know the properties of air and to know the needs of the human body when we consider the ventilation of the salon.

In order to be healthy and comfortable human beings need to be surrounded by fresh air.

Fresh Air

(a) Fresh air is moving, (b) It is free from dust, harmful fumes, smoke and infection, (c) Its temperature and humidity are at a comfortable level, (d) It stimulates breathing, allows loss of body heat and hinders the spread of airborne disease organisms.

A hairdressing salon becomes hot and humid as the day's work goes on. The air in the room is warmed by the heat from hot water, hair dryers, curling irons, steamers and the bodies of people in it.

Water is continually evaporating in a salon, from the hot water used for shampooing and rinsing, from wet hair and towels and from perspiration on the bodies of staff and customers. This means that it is turning into water vapour and entering the air. Water vapour is also breathed out by everyone in the salon.

The warmer the air becomes the more water vapour it can hold.

If the air in the salon is not changed but remains stationary it will grow warmer and warmer and hold more and more water vapour. It will also have in it more carbon dioxide and many minute organisms of disease breathed out by the occupants. Smells from permanent waving lotions will also be present. The people in the salon will feel uncomfortable and ill because their bodies cannot lose heat.

A human body can lose heat by radiation to air around it if that air is at a lower temperature than the body. If the temperature of the air rises to that of the body and it is not moving, then no heat can be lost from the body. Perspiration can normally evaporate from the surface of the body and cool it, but if the air cannot hold any more moisture, then perspiration cannot evaporate and this method of cooling the body fails.

It is important that matters should never reach this state and therefore salons are so ventilated that all the air in the room is changed about three times each hour.

To ventilate a room means to allow the entry of fresh air and the removal of stale air without causing draughts. It would be

uncomfortable if the air in the salon were moving so quickly that draughts were caused. People with wet heads especially feel cold in a draught because the water on the hair evaporates quickly and the temperature on the head falls noticeably.

Methods of Ventilating Salons

We can ventilate a salon by natural or by artificial means.

A. *Natural Ventilation* takes advantage of what is known about the behaviour of gases, since air is a mixture of gases. We know that a gas diffuses easily. This means that gas travels through other gases and spreads out throughout the whole of whatever space is available to it. If someone drops a bottle of ammonia at one end of the salon everyone anywhere in the salon, even at the furthest end, will soon smell it. The gas arising from the spilt ammonia has diffused through the air. The gases making up air are constantly diffusing. We are not affected by the carbon dioxide which everybody is breathing out all the time because it spreads out through the nitrogen and oxgyen very quickly.

We also know that warmed gases are lighter than colder ones and therefore tend to rise, so warmed air will rise in a room. In most houses ventilation is no problem because used, warm air rises up the chimney and fresh air comes in through doors and windows, but a salon has no open fireplace and so warm air has to have other outlets.

1. The first natural way to ventilate an overheated salon is just *to fling open the windows*. Fresh air will then blow in and stale air will be drawn out. But there are disadvantages in this.

(a) It is difficult to control the speed with which fresh air will blow in. Draughts may be caused which will make customers uncomfortable.

(b) Little bits of cut hair may blow all over the salon. Some of this hair will be dirty and may contaminate the surfaces it falls on.

(c) Dust and smoke may come in with the air. If there are factories or laboratories in the area unpleasant smells may also enter. The fumes from exhausts of motor vehicles will enter if

there is a busy street outside. Since the passing of the Clean Air Act in 1956 the air in cities is much cleaner than it used to

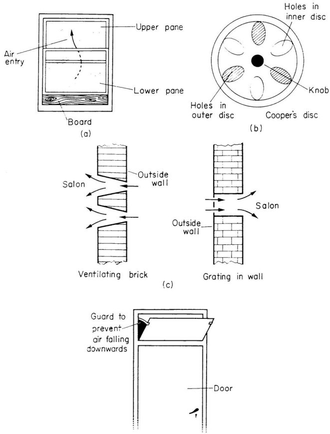


FIG. 51. *Some methods of ventilation.*

be because the burning of fuels which produce smoke is controlled, but conditions are not good in all areas.

(d) It is difficult to control variations in temperature. Cold air entering on a winter day may reduce the temperature in the salon too quickly for comfort.

Nevertheless, many salons depend only on windows and fanlights over doors for their ventilation. They adjust the amount the windows are open to the temperature and humidity of the salon. Some air, of course, enters under doors.

2. A better arrangement is to take advantage of *convection currents* in air. Warm air rises and cooler air takes its place, so that if there are outlets for the warm air high in the room and inlets for cooler air lower down the air will circulate throughout the room. The cool air should not come in at floor level because this may cause draughts around the feet, but it can be allowed in above head level and in an upward direction so that it is slightly warmed before it falls downwards. In this way no discomfort is noticed by people with wet heads. If the outlets are smaller than the inlets the air will not circulate too quickly.

There are several ways of arranging this natural ventilation in salons.

(a) The lower sash of the window can be raised a little and the space thus made can be blocked up. Air then comes in in an upward direction between the panes.

(b) Modern metal casement windows have fastenings which allow very small amounts of air to come in round the edges. In this case the air does not come in above head level but the amount is too small to cause discomfort.

(c) Cooper's discs can be fitted to the windows. A circular hole is cut in each window-pane and filled with two circles of glass each of which has a number of holes in it. The circle on the inside of the pane can rotate so that the holes can be opened or closed.

(d) Hopper inlets can be fitted at the tops of windows. They are panes of glass hinged at the bottom so that they fall open inwards and air enters upwards. There are guards at the sides to prevent air falling immediately downwards.

(e) Ventilating bricks or gratings can be built into the wall.

Outlets for warmed air usually take the form of sash windows opened a little at the top or some form of ventilating bricks or gratings high on an outside wall. If the salon is on the top floor of a building there may be a skylight to open or a louvred grating in the ceiling.

B. *Artificial Methods of Ventilation* may be simple or very elaborate and expensive.

1. *Extractor fans.* These, set in an outside wall, suck out stale air from the salon. They can be bought in different sizes, and the speed of their action can be adjusted. If they work too vigorously they can cause draughts and lower the temperature of the salon too quickly. The hairdresser soon learns how to adjust them to the prevailing conditions in the salon. They are particularly useful in small salons where two or three may be fitted.

2. *Exhaust system.* Stale air is sucked into ducts by powerful fans and directed into the outside air. Fresh air comes in naturally through doors and windows.

3. Air is drawn in by fans, freed from dust, and blown by pressure into the salon. Stale air goes out through the usual exits. This is called the *Plenum system.*

4. *The Balance system* is a combination of these two methods. Two large fans, one to draw fresh air in and one to extract stale air, are situated on the roof of the building. Air is carried along to the salon in large ducts. The air comes into the salon from grated holes in the ceiling and is extracted through gratings lower down on the walls, so that the cold air is warmed before it reaches the customers' heads. In most large open salons the entrances and exits for the air are on opposite sides of the room so that the air circulates right through the salon. In a salon where cubicles are used the walls of the cubicles should not reach the ceiling, so that the fresh air coming from the inlets in the ceiling may reach all cubicles. There is usually one outlet for each two cubicles.

These last three methods of ventilation are sometimes known as "Trunk" systems, possibly because the ducts which carry the air in and out look like enormous elephants' trunks.

5. *An air conditioning plant* (this is an elaboration of 4). It is expensive and complicated, but a large salon may use one. Air is not only brought in and taken out mechanically but its condition is also altered. Air is brought in by fans from outside, usually under the roof. It is cleaned, warmed or cooled as is necessary, and has the water vapour level adjusted before being admitted to the salon. After it circulates it is withdrawn.

FIG. 52. *The balance system in a salon. Inlet duct grilles in false ceiling which hides the ducts; outlet grille on right wall. Large fans are on roof.* (*Courtesy of Oxford and District Co-operative Society.*)

6. Small, compact, *air-conditioning units* can now be obtained and fitted to windows, walls or floor in the smaller salon.

Condensation

Hairdressers sometimes complain that mirrors "mist up" and that windows cloud over and moisture appears on walls. This is caused by condensation of water vapour. Air always holds a certain amount of water vapour and the warmer air becomes the more water vapour it can hold. At any given temperature, however, there is a limit to the amount of water the air can hold. If a given volume of air is holding as much water vapour as it can, it is said to be saturated. Now, if air saturated with water vapour is suddenly cooled, it will deposit some of the water vapour in the form of water. Mirrors and windows and, to a lesser degree, walls tend to be cool surfaces and therefore the air in contact with them will be cooled and some of its water vapour will condense—that is, turn back into water. This deposit of water is what clouds up the mirrors and windows. It is the same process as that which occurs in the distillation of water (see page 132). If mirrors constantly cloud up in a salon it means that the ventilation of the room is not efficient, because air should not reach saturation point in a well ventilated room.

Mirrors which stand too close to washbasins will "mist up" because steam will condense on them. This can be avoided by moving the mirrors further from the basins, but the mirrors will grow warmer as work in the salon goes on and there will be less misting.

Exercises on Heat and Ventilation.

1. Breathe onto a mirror and watch the water vapour in your breath condensing.
2. Pour very cold water into a tumbler in a warm room and see what happens.
3. Look at the hot water system, and the heating system, in your salon.
4. How is your salon ventilated?
5. Visit your local Gas Board and Electricity Board showrooms and ask for illustrated pamphlets about space heaters and water heaters.

XII
THE AIR, ITS COMPOSITION AND PRESSURE

AIR IS A MIXTURE

THE composition of the air varies a little from place to place, but generally contains the following.

Nitrogen—4/5ths of the air (78 per cent)
Oxygen —1/5th of the air (21 per cent)

Also present in the air are waste gases, solids and water vapour. The presence of bacteria and fungal spores must not be overlooked.

AIR HAS WEIGHT

All matter has weight. Air is matter therefore air has weight.

Experiment to demonstrate that air has weight

A balloon full of air is placed upon the left hand scale-pan of a chemical balance. The balloon is balanced by pieces of torn paper on the other scale-pan.

When the balance hangs steady, the air in the balloon is removed. The scale pans will tip towards the right hand side when the air is removed showing that some weight has been removed from the other pan.

AIR HAS A PRESSURE

We live at the bottom of a very deep sea of air, the atmosphere stretches for some 50 miles above our heads. Since air has weight, then this air above us must press down upon us. This pressure is 15 lb per square inch.

Experiment to demonstrate that air has a pressure in all directions

A thin-walled tin with an inch of water in the bottom is heated until the water boils. When the steam from the water has pushed out all the air from the tin a cork or rubber bung is placed in the opening of the tin.

The tin is then rapidly cooled by means of cold water. The steam changes back to water, thus leaving no air (a vacuum) in the tin. The great pressure of the atmosphere around crushes the walls in.

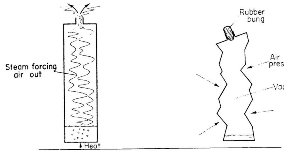


FIG. 53. *Atmospheric pressure.*

Measuring Air-Pressure

The air-pressure varies from place to place and from day to day.

The air pressure *at sea-level* is approximately 15 lb per square inch.

The air pressure *below sea-level* is more than 15 lb per square inch.

The air pressure *above sea-level* is less than 15 lb per square inch.

On a weather map regions of the same air-pressure are joined together by lines. These lines are called *Isobars*. A map of this sort assists in weather prediction. Air-pressure and its variation are measured by means of the barometer.

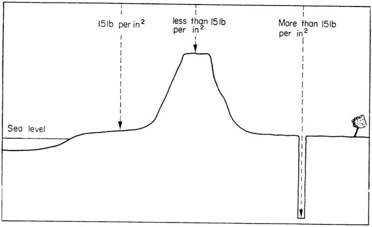


FIG. 54. *Atmospheric pressure.*

Experiment. Making a simple mercury barometer.

A long glass tube over 30 inches long, closed at one end, is filled with mercury. A finger is placed over the open end and the tube is placed upright over a bowl of mercury. A small amount of the mercury will run out into the bowl leaving a space above the mercury in the tube.

If the height of the mercury standing up in the tube is measured it is seen to be 30 inches or 76 cm or 760 mm. Thus the atmosphere (15 lb per square inch) at sea-level will support 30 in., 76 cm or 760 mm of mercury.

If the atmospheric pressure drops then so will the level of the mercury in the tube. If the atmospheric pressure holding up the mercury increases, then so will the level of the mercury rise.

Barometer readings are quoted as being so many inches, centimetres or millimetres of mercury.

A low pressure if often associated with rain. A high pressure is generally associated with dry weather.

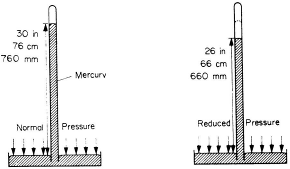


FIG. 55. *Mercury barometer.*

The Modern Wall-barometer—the Aneroid Barometer

The mercury barometer is rarely found outside the laboratory. The usual wall barometer is based upon the principle described below.

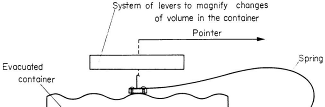


FIG. 56. *Aneroid barometer.*

The metal container is evacuated of all air. It is prevented from collapsing by the spring. Any variations in air pressure will cause the vacuum container to alter its volume. An increase in air pressure will bring a greater pressure to bear upon the vacuum and the pointer will move.

The Gases in the Air

Oxygen occupies only 1/5th volume of the air, but it is the most important gas because it is necessary for *respiration*, *rusting* and *burning*.

Experiment to demonstrate the need for air in respiration.

Breathing involves the intake of air which contains oxygen necessary for respiration.

Respiration is the process of "burning" sugars by the body tissues in order to give rise to energy. The waste products of this process are carbon dioxide and water.

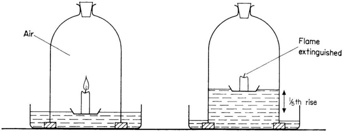


FIG. 57. *Oxygen necessary for burning.*

For the body to make energy by respiration, oxygen is necessary. Animals therefore inhale air which contains oxygen. The number of times per minute that we breathe in is not normally under our conscious control, nor is the "depth" to which we inhale. These actions are automatic, depending upon the amount of carbon dioxide waste that is collecting in the blood-stream. We can show the demand for air that our bodies make by consciously slowing our breathing to almost stopping. After a short

spell of this type of breathing an overpowering demand for air makes us take a deep breath or two. Yawning is essentially the same thing. The carbon dioxide in the blood stream builds up as a result of inactivity or slow breathing and a compulsive deep breath is taken.

Experiment to demonstrate that oxygen is necessary for burning and that oxygen occupies approximately 1/5th volume of the air.

A lighted candle is floated on water in a tin-tray beneath a bell-jar. As the candle burns up the oxygen in the jar the water level moves up the bell-jar to take the place of the oxygen removed.

When the height that the water has risen up the jar is measured, it is seen to be approximately 1/5th of the jar's total volume. The remaining gas is tested with a glowing splint, it does not burn, thus all the gas necessary for burning has been removed. The remaining gas is nitrogen.

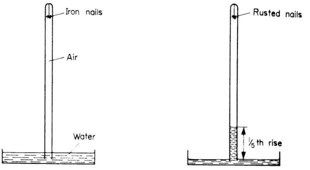


FIG. 58. *Rusting. Oxidation of iron.*

Experiment to demonstrate that oxygen is necessary for rusting.

A small bunch of iron-nails or iron-filings are suspended above water in a tall-tube standing over water. The iron will rust if left suspended like this for a period of a few days. The iron combines with the oxygen of the air to form iron oxide (rust). This process of combining with oxygen is called *oxidation.*

The level to which the water has risen up the tube is seen to be approximately 1/5th of the tube's volume. The remaining gas is tested with a glowing splint, it does not re-light as it would do were it oxygen.

XIII
SIMPLE CHEMISTRY IN HAIRDRESSING

ELEMENTS

CHEMISTRY is concerned with *elements* and their various combinations into millions of different compounds.

An *element* is the purest form of matter made from particles which are all the same. For example, copper, iron, sulphur or carbon are elements. When they are broken down into the smallest possible particles, they still remain the same substance.

The smallest particle of an element is the *atom*. The atom is constructed of a central part called the nucleus circulated by electrons.

There are just over one hundred elements from which everything in the world is made.

Elements may be divided into two main groups:

Metal elements	*Non-metal elements*
Sodium	Carbon
Potassium	Sulphur
Calcium	Oxygen
Magnesium	Chlorine
Zinc	Hydrogen
Copper	Nitrogen

Above are a few of the commoner elements.

OXIDATION

Both metals and non-metals will combine with oxygen from the air to form compounds called *oxides.*

The process of combining with oxygen is called *oxidation.* *A Base* is a metal combined with oxygen.

Metal + oxygen = metal oxide (a base)
e.g. iron + oxygen = iron-oxide (rust)
sodium + oxygen = sodium oxide.

Iron oxide will not dissolve in water, sodium oxide will dissolve in water.

When a base is dissolved in water it is known as an *alkali* (then named a *hydroxide*).

e.g. sodium oxide + water = sodium hydroxide
base + water = alkali.

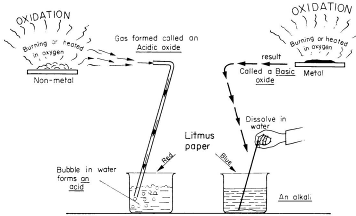


FIG. 59. *Acids and alkalis.*

An acidic oxide is a non-metal combined with oxygen.

Non-metal + oxygen = non-metal oxide (acidic oxide)
e.g. carbon + oxygen = carbon dioxide
sulphur + oxygen = sulphur dioxide.

When an acidic oxide (usually a gas) is dissolved in water, an *acid* is formed.

e.g. carbon dioxide + water = carbonic acid
sulphur dioxide + water = sulphurous acid.

ALKALIS AND ACIDS

In order to recognize an acid and an alkali an *indicator paper* is useful.

An indicator paper is dyed paper which changes its colour when in contact with an acid or alkali.

Litmus paper

Red paper turns blue when in contact with alkalis. Blue paper turns red when in contact with acids.

pH paper.

This paper is used when a more accurate measure of *acidity* or *alkalinity* is needed. This paper will change colour to a particular shade between red and blue depending on how much acid or alkali is present.

The different shades are numbered on the cover of the booklet which holds the paper, as below.

Very red		Yellow		Blue
pH = 1	$\rightarrow$	pH = 7	$\rightarrow$	pH = 14
Very acid		Neutral		Very alkali

Some alkalis and acids commonly found in the laboratory are listed below.

Alkalis	*Acids*
Sodium hydroxide	Sulphuric acid
Potassium hydroxide	Hydrochloric acid
Ammonium hydroxide (a gas dissolved in water)	Nitric acid

SALTS

When an acid and a base (or alkali) are mixed together a chemical reaction takes place and a *salt* is formed.

Acid + base (or alkali) = salt + water

Examples

Sodium hydroxide + Hydrochloric acid =
(alkali) (acid)
Sodium chloride + water
(table salt)

Copper oxide + Sulphuric acid = Copper sulphate + water
(base) (acid) (blue vitriol crystals)

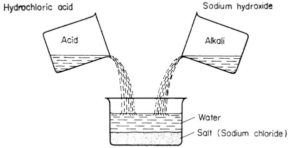


Fig. 60. *Making a salt.*

ACIDS, ALKALIS AND SALTS USED IN HAIRDRESSING

Properties of an Acid

(a) An acid will turn blue litmus paper red.
(b) An acid has a pH from 1–7.
(c) An acid will cause skin burns and corrode metals.
(d) An acid will break down *carbonates* (e.g. limestone) and carbon dioxide will be given off.
(e) An acid added to a base or alkali will form a salt.
e.g. Sulphuric acid forms *sulphates*
Hydrochloric acid forms *chlorides*
Nitric acid forms *nitrates*
Acetic acid forms *acetates*
(f) Some acids are formed when an acidic oxide is dissolved in water.

Acetic Acid

(Vinegar contains diluted coloured acetic acid.)

Properties: A colourless liquid with a characteristic smell. The dilute acid is not dangerous but should be washed off the skin or clothing if spilt. It will react with alkalis or bases to form *acetates*.

Making the Acid

Acetic acid is produced when ethyl alcohol is oxidized. This oxidation may be brought about as follows:

Stale beer is dripped through beech wood shavings containing a mould (*Mycoderma aceti*) which oxidizes the alcohol to acetic acid.

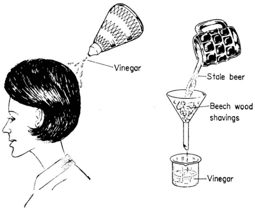


FIG. 61. *Vinegar rinse.*

Using Acetic Acid in Hairdressing

A dilute vinegar rinse helps to make the hair more manageable after a shampoo. This rinse may help to break down any

lime salts left in the hair after a soap shampoo has been used with fairly hard water. A vinegar rinse generally makes the hair easier to comb.

A small amount of acetic acid added to henna will cause the colour to be redder than usual.

Citric Acid (Lemon rinse)

Properties: A white crystalline substance resembling salt grains. It forms salts called *citrates*.

Citric acid is obtained from fresh citrus fruits such as lemons.

Using Citric Acid in Hairdressing

This acid is used for the same reasons as acetic acid. The hair is easier to manage after a lemon rinse, but this acid is not so effective on bleached hair as is acetic acid.

Salicylic Acid

Properties: A white crystalline substance with a caustic action on the skin. It has disinfectant properties. When added to a solution containing iron salts it turns *violet*.

Using Salicylic Acid in Hairdressing

This acid is used in hair preparations as a preservative. If a solution containing this acid as a preservative is used, then a test must be made on a small portion of the hair first. Hair containing iron salts will be coloured a violet tint if salicylic acid preparations are used. It is a good antiseptic.

Thioglycollic Acid

Properties: A yellowy liquid with a very unpleasant odour. This acid will burn the skin. It forms salts called *thioglycollates* with bases or alkalis.

Using Thioglycollic Acid in Hairdressing

The pure acid is not used in hairdressing. The ammonium salt—*ammonium thioglycollate* is the basis of most cold wave lotions. This substance changes the molecular structure of the hair.

Calcium thioglycollate is the basis of most modern depilatories.

Hydrogen Peroxide

Properties: Hydrogen peroxide is not an acid, but follows the section on acids because it has certain acid properties. It turns blue litmus paper red. Strong solutions of hydrogen peroxide will burn the skin.

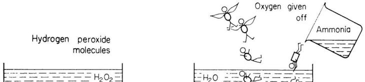


FIG. 62. *Ammonia decomposes peroxide.*

A solution of hydrogen peroxide will decompose when warm, in light, on shaking or when ammonia is added to it.

When hydrogen peroxide decomposes oxygen is given off.

Hydrogen peroxide $\longrightarrow$ water + oxygen.

It is the oxygen which makes peroxide useful to the hairdresser.

Hydrogen peroxide has disinfecting properties.

Bottles of peroxide are sold as 10 volume, 20 volume or 30 and 40 volume and rarely 100 volume solutions.

This means:

10 *Volume Hydrogen Peroxide*

1 ml of the solution will yield on heating 10 ml of oxygen.

20 *Volume Hydrogen Peroxide*

1 ml of the solution will yield on heating 20 ml of oxygen.

30 *Volume Hydrogen Peroxide*

1 ml of the solution will yield on heating 30 ml of oxygen

Hydrogen peroxide will decompose easily in sun light or heat, thus is must be stored in a dark, cool place, preferably in pint bottles, not large vats.

Using Hydrogen Peroxide in Hairdressing

(a) The oxygen given off from peroxide is used for bleaching the hair pigment. This is an oxidation process.

(b) Hydrogen peroxide is used to supply the oxygen necessary in order to oxidize small, often colourless, molecules of *para-dye* (a common type of oxidation tint). The oxidized para-dye has large molecules. These become trapped in the hair shaft, thus forming a permanent dye.

(c) Hydrogen peroxide is used as a "*neutralizer*" after a permanent waving solution has been used. The cold wave solution breaks down the molecular structure of the hair and the "neutralizer" sets the new structure. "Neutralizing" after a perm is an oxidation process.

(d) *Diluting hydrogen peroxide*. Using 40 volume peroxide solution.

To obtain 30 vol. add 3 parts to 1 part of water.

To obtain 20 vol. add an equal quantity of water.

To obtain 10 vol. add 1 part to 3 parts of water.

To obtain 5 vol. add 1 part to 7 parts of water.

Using 30 volume peroxide solution.

To obtain 20 vol. add 2 parts to 1 part of water.

(e) *Peroxide tablets* are available. These tablets are added to water and a solution of peroxide of the required strength is obtained. This solution must be used immediately as it will decompose quickly with tap water.

Properties of an Alkali

(a) An alkali is usually the *hydroxide* of a metal (a base dissolved in water). Ammonium hydroxide is a common alkali—but *not* a metal hydroxide.

(b) Alkalis will turn red litmus paper blue.

(c) An alkali has a pH from 7 to 14.

(d) The hydroxides of potassium, sodium and calcium are caustic (will burn the skin).

(e) An alkali will react with an acid to produce a salt and water.

(f) Alkalis will remove grease from surfaces on contact.

Ammonia

Ammonia is a choking, colourless gas which very rapidly dissolves in water. When dissolved in water it becomes a powerful alkali called *ammonium hydroxide.*

Properties of ammonium hydroxide: It is a colourless solution of ammonia in water. Ammonium hydroxide will lose ammonia on standing.

Ammonium hydroxide as an alkali will react with acids to form salts called ammonium salts.

Uses of Ammonium Hydoxide in Hairdressing

Ammonia solution may be supplied to the salon in large brown bottles labelled "Ammonia Fort" (S.G. 0·88). This bottle contains 35 per cent ammonia dissolved in water. The figure 0·88

refers to the *specific gravity* of the solution. Ammonia solution will decompose if heated or exposed to sunlight. Thus it is best kept in a cool dark place. The strong solution of ammonia must be diluted before use on the hair or skin.

A dilute solution (one part 0·88 ammonia to 50 parts 20 vol. hydrogen peroxide) of ammonia is used in bleaching to assist in the breakdown of hydrogen peroxide to give oxygen and water. The oxygen does the bleaching.

Hydrogen peroxide $\longrightarrow$ water + oxygen.

The ammonia also acts as a "wetting agent", that is it "breaks down the resistance" of the hair thus allowing oxygen to penetrate the hair more easily. If ammonia or ammonium salts are used in perming it is for this wetting action (see surface tension).

A *precaution* is necessary when bleaching the hair, because if too much ammonia is used and the hair contains iron, the oxygen from the peroxide will combine with the iron to form iron oxide (rust). This oxide will give the bleached hair a red tinge. (Use plastic containers when mixing bleaches or tints.)

Sodium Hydroxide

This is a colourless liquid with a soapy "feel" to it. This alkali when concentrated is very *caustic*. Another name for sodium hydroxide is caustic soda. Caustic soda is boiled with fats to produce hard soaps such as *sodium stearate*.

Potassium Hydroxide

This is a caustic alkali which is generally more powerful than caustic soda. It is known as caustic potash. When this alkali is boiled with vegetable oils soft soaps are produced such as *potassium oleate* (olive oil soap).

Calcium Oxide (Quicklime)

This white powder is a base which dissolves in water and gives off heat. Calcium hydroxide is produced when this happens.

The heat produced by adding water to calcium oxide is used in hairdressing in the chemical pads of machineless permanent wave outfits.

Calcium oxide will burn the hands by removing the moisture.

Properties of a Salt

A salt is usually crystalline, white or coloured. A salt is usually neutral to litmus and registers a pH of 7.

Ammonium Carbonate

On the occasions when liquid ammonia is not convenient, a paste of ammonium carbonate will give off ammonia when moistened with water. Ammonium carbonate is used as a wetting agent; it is mixed with magnesium carbonate in white henna.

Ammonium Thioglycollate

This is the salt of thioglycollic acid and ammonium hydroxide.

This salt is contained in cold perm solutions which is adjusted to a pH of 9–9·5 (alkaline). If the pH of this solution rises from 9–11 then the perm solution alters the molecular structure of the hair and becomes a depilatory. Care should be exercised when using this solution on the hair because it will produce a reddish colour if iron salts are present in the hair molecule.

When using cold wave solutions rubber gloves or a barrier cream are advisable.

Calcium Carbonate (Chalk)

A whitish substance used in dusting powders and tooth pastes.

Copper Salts e.g. copper sulphate

Copper salts were at one time commonly found in hair dyes which give a brownish-black tint to the hair. This colour is formed when the copper sulphate changes to copper oxide.

Borax

This white crystalline salt was at one time used in paste form for permanent waving, using hot tongs. Some baby soaps contain borax as a mild alkali.

Potassium Carbonate

This salt has similar properties to those of washing soda (sodium carbonate). It is used for cleaning greasy materials and is often found in soap creams for brushless shaving.

Potassium Permanganate

This is a salt with small purple crystals which easily dissolve in water to form a purple solution. Solutions of permanganate have been used in hair dyes to give a brownish colour.

Permanganate solutions are useful antiseptics for gargles, etc.

Silver Salts

These salts may be used in the same way as copper or iron salts, to give dark colours to the hair.

Silver salts when used in hennas give a black colour.

Sodium Carbonate (Washing soda)

This salt is generally used for softening water, if soapless detergents are not used. Bath salts are a perfumed variety of washing soda.

Sodium Sulphide

This substance may be present in some cold wave solutions. When dissolved in water it gives off fumes of rotten eggs (hydrogen sulphide).

Older forms of hair dye containing salts of copper, silver or iron in solution, required the addition of sodium sulphide solution in order to produce the black colours. This black colour was deposited upon the hair.

Sodium Sulphite

A reducing agent used in some permanent wave solutions. Reducing agents remove oxygen or add hydrogen to chemical compounds.

Zinc Oxide

A white powder produced if zinc is burnt in oxygen. Often used together with zinc carbonate to form a *calamine* lotion, an astringent used in sun burn preparations.

OILS AND EMULSIONS

The Essential Oils

The solvents mentioned previously are often used to dissolve the *essential oils* used in soaps and cosmetics as perfumes.

The essential oils are "essences" extracted from plants. These oils in general have very noticeable odours. These oils are usually highly volatile (evaporate readily) and molecules of the vapour diffuse widely throughout the atmosphere.

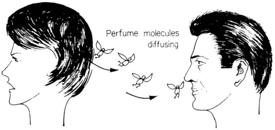


FIG. 63. *Perfume molecules diffuse.*

Below are listed a few of the essential oils:

Oils in flowers carnation, clove, hyacinth, heliotrope, mimosa, jasmine, orange blossom, rose, lavender and violet.

Oils in flowers and leaves rosemary, lavender, violet, menthol and peppermint.

Oils in the wood turpentine, camphor and cedar.

Oils in fruits lemon, lime and orange.

Oils in seeds caraway, bitter almonds, anise and nutmeg.

Mineral Oils

The use of mineral oils in the craft has an advantage over the use of vegetable oils because they do not go rancid. Liquid paraffin of a *low viscosity* (more "watery" than some paraffins) is used in some brilliantines with a small amount of vegetable oil added together with perfumes and preservatives.

Soft petroleum jelly (a soft paraffin) is the main constituent in vaseline.

Vegetable Oils

These are oils obtained from plant sources used in the preparation of toilet soaps and as a constituent in many hair dressings with an "oily" base.

A few examples of vegetable oils are—palm oil, olive oil, almond oil, castor oil.

Emulsions

An emulsion is an intimate mixture of two liquids which are immiscible under ordinary conditions. The substances that make up the emulsion do not separate out from one another.

e.g. oil and water emulsions.

The oil/water emulsion may be of two types:

(a) *Oil in water emulsion.* Oil globules dispersed in water. Many toilet preparations are of this type, such as hair creams, cleansing creams and "milky" lotions. These emulsions should be stable, that is the two components must not separate out. A chemical agent which assists this emulsification is called an *emulsifying agent.* An emulsifying agent puts a film around the droplets and prevents them from "coming together". Sodium and potassium soaps, triethanolamine, gums and the partially sulphated fatty alcohols are emulsifying agents for oil in water.

(b) *Water in oil emulsion.* Water globules dispersed in oil. Emulsifying agents of this type of emulsion are the wool wax alcohols. These emulsions are best prepared at low temperature.

Most creams and oily lotions used in the salon are stable emulsions of oily and watery substances.

STERILIZING FLUID

(a) *Formalin*

The sterilizing cabinet has a solution vaporized and circulated within it. This vapour destroys biological organisms likely to

cause disease. The chemical reagent in the solution is a substance called *formaldehyde*.

The solution is sold as *formalin* (37 per cent–40 per cent *formaldehyde*). This liquid is diluted down 3 oz to 2 quarts of water to make a sterilizing fluid.

(b) *Quaternary Ammonium Compounds*

This group of compounds are very effective disinfectants. The advantages of this substance are that it is odourless, non-toxic and stable. The time required for sterilization is very short also—from 1 to 5 minutes depending on the strength of the solution. A solution 1 in 1000 is used for disinfecting instruments by immersion.

(c) *Alcohol*

Instruments with very sharp cutting edges and the glass electrodes of the high-frequency apparatus are best sterilized by being rubbed over with 70 per cent alcohol.

XIV
WATER AND OTHER SOLVENTS

THE TAP

THE water supplied to the salon usually enters through the simple screw-type tap. A popular tap is the "mixer" type illustrated below. This type of tap allows us to obtain water of a suitable temperature without too much bother.

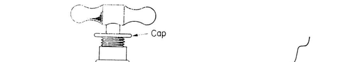


FIG. 64. *The tap.*

EXERCISE.

Take an old tap to pieces and examine the washers. Attempt to fit a new washer to the tap. Try to find out why some taps "rattle" when they are turned on.

THE WATERWORKS

The type of water supplied to the salon will depend on:

(a) The kind of rocks found in the area through which the water runs before reaching the salon.

(b) The treatment the water receives at the hands of the local water authority.

The water will in general have come from a reservoir which will be situated at a level above the town.

The water reaches the reservoir as a result of the natural water cycle.

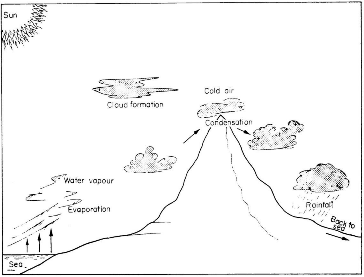


FIG. 65. *The water cycle.*

EXERCISE.

Why is the reservoir above the town? Where is your local reservoir? Write to your local water authorities for information concerning the treatment water receives before it reaches your salon.

WATER AND ITS SURFACE TENSION

If a needle is floated upon a piece of tissue-paper, the tissue-paper will absorb water and sink. If the needle is not too heavy it will remain suspended upon the surface of the water. This is possible because the water has a type of "skin", or boundary which must be broken before anything is able to "penetrate" the water. This boundary is due to the *surface tension* of the water molecules.

In order to make full use of water in washing or any other process in the salon, the surface tension of the water must be reduced. An agent which reduces this surface tension is called a *wetting-agent*—for example, ammonia or detergents.

HARD WATER

When some water is used with soap or shampoos of a soap type, a lather is difficult to obtain and a great deal of scum may result from the effort. This type of water is usually referred to as *Hard water*. Hard water is water which contains certain salts dissolved in it. The types of salts dissolved in the water will depend upon the rocks over which or through which the water has flowed. These salts will prevent a decent lather with soap and a scum will be formed. (*Calcium-soap.*)

EXERCISE.

Examine the inside of a kettle that has been used for some length of time, note the lining of a "chalky fur". This "fur" is caused by the salts in the hard water. Is your water hard or soft? Does your salon have a water-softener?

Types of Hard Water

There are two types of hard water:

1. Temporary hard water. 2. Permanent hard water.

1. *Temporary hard water* contains a salt picked up from chalk rocks called *calcium bicarbonate*. This water is known as temporary hard water because it may easily be softened by boiling.

Softening Temporary Hard Water

(a) When water containing *calcium bicarbonate* is boiled, the bicarbonate changes to the carbonate.

$$\text{Calcium bicarbonate} \xrightarrow{\text{heat}} \underset{\text{(settles to the bottom of water)}}{\text{Calcium carbonate (chalk)}}$$

The calcium carbonate (the "fur") may be removed if need be, but since it does not dissolve in water it doesn't influence the lather of soap.

(b) another method of softening temporary hard water is by the addition of washing soda (sodium carbonate). When the carbonate of soda is added to water, the carbonate joins up with the offending calcium. This, calcium carbonate again settles out of solution.

$$\text{Calcium bicarbonate} + \underset{\text{(washing soda)}}{\text{Sodium carbonate}} \longrightarrow \underset{\text{(chalk settles out)}}{\text{Calcium carbonate}} + \text{Sodium bicarbonate}$$

By both these methods the calcium is being taken out of the solution. It is the calcium that combines with soap to form scum (calcium soap).

2. *Permanent hard water.* Water containing a salt called *calcium sulphate* (Gypsum) dissolved in it, is known as permanent hard water. It is so called because it may not easily be softened. Boiling has no effect.

Softening Permanent Hard Water

(a) The addition of washing soda to permanent hard water will cause the calcium to come out of the solution and settle on the bottom of the container as calcium carbonate (chalk).

$$\underset{\text{(hardening salt in water)}}{\text{Calcium sulphate}} + \underset{\text{(washing soda)}}{\text{Sodium carbonate}} = \underset{\text{(chalk settles out)}}{\text{Calcium carbonate}} + \text{Sodium sulphate}$$

(b) The more usual method of softening permanent hard water (and temporary hard water) is to pass the water through a water softener. The simplest type of softener to understand is the following.

Permanent hard water containing calcium sulphate is run through a sand-like chemical (a *zeolite* as it is sometimes known) called *sodium aluminium silicate*. This water softening chemical is given the trade name of *Permutit*. The water softener will take out the calcium from hard water and give up its sodium in exchange.

Sodium aluminium silicate + *Calcium* sulphate ——→
Calcium aluminium silicate + Sodium sulphate.

The scum forming calcium is now in the water softener.

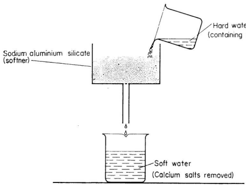


FIG. 66. *Softening permanent hard water.*

After a length of time all the Permutit changes to *calcium* aluminium silicate. In order to renew the softener it is necessary to put back the sodium. The Permutit is renewed by washing it in a solution of *sodium* chloride (salt-water). The sodium pushes out the calcium and fresh sodium aluminium silicate is ready for use.

Calcium aluminium silicate + *Sodium* chloride ——→
(salt solution)
Sodium aluminium silicate + Calcium chloride.

The Need for Soft Water in Hairdressing

If the water in the salon is hard, then much soap and effort will be wasted in attempting to shampoo. This statement applies largely to soap shampoos, although they are less frequently used now.

A hard soap (sodium stearate) will combine with the calcium in hard water to form a scum, calcium stearate. This wastes much of the soap.

Shampooing is mainly performed now with detergent substances of a non-soap nature, the soapless shampoos. These shampoos do not form scum as do soaps.

Distilled Water

One certain method of removing salt impurities from water is by a process called *Distillation*. The apparatus used in this process is seen below. The water containing salts is heated in the

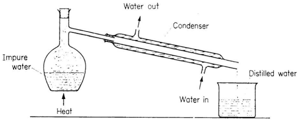


FIG. 67. *Distillation apparatus.*

flask to boiling point. The water vapour produced at boiling point passes down the water-cooled tube called the *condenser*. The water which is collected is called *Distilled water*, it contains no salts, it is therefore soft water.

Need for Distilled Water in Hairdressing

The steamer apparatus is normally used with distilled water. Distilled water is used in preference to normal tap water in order to prevent the "clogging up" of the apparatus due to residues of salts which would be present in ordinary tap water. It is used in the preparation of cosmetics and toilet waters such as Eau de Cologne. It is used for diluting cold wave lotions.

Condensation in the Salon

Water vapour is turned back into water when its temperature falls. Water vapour changing back to water is known as *condensation.* Condensation takes place on cold surfaces such as windows in the salon or mirrors. They thus become "steamed up".

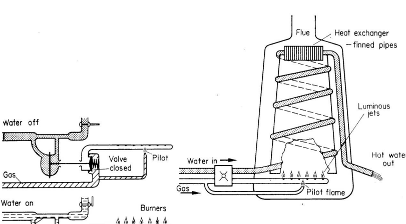


FIG. 68. *Instant hot water system.*

Instant Hot Water

Hot water may be obtained instantly by means of a water heater which switches on immediately the water tap is turned on. A pilot light burns inside the heater and when the water is flowing the mains gas is allowed to pass to the main jets or burners.

This automatic principle is illustrated in Fig. 68.

WATER AS A SOLVENT

If any solid, liquid or gas dissolves in water, then it is said to be *soluble* in water.

The substance which dissolves is called the *solute*. The liquid in which the solute dissolves is called the *solvent*.

When a solvent contains a solute dissolved in it, then it is known as a *solution*.

EXAMPLE:

Salty water is a solution of salt (solute) in water (solvent).

Water is the most common solvent used in hairdressing but it will not dissolve fat or grease.

OTHER SOLVENTS

Acetone

A colourless *inflammable* liquid which tends to dry the skin because it dissolves water. It has a sweet smelling vapour. It is a solvent of fats and oils. It will also dissolve certain man-made fibres so care should be exercised if using this solvent to remove stains.

Acetone is used as a solvent together with *amyl acetate* in nail varnishes and nail-varnish remover.

Alcohols

Ethyl alcohol is a colourless inflammable liquid with a tendency to dry the skin by absorbing water. It is a sweet smelling liquid. It is a solvent of fats and oils. It may be used as a solvent for the *essential oil* perfumes. Ethyl alcohol is the drinkable alcohol and is made by fermenting sugars. A common name for preparations containing alcohols of one sort or another is "spirits".

A common use for the alcohols is to dissolve lacquers and some of the so-called "dry-shampoos".

Astringents are also alcoholic, such as after-shave lotions.

Methyl alcohol is a colourless inflammable liquid which again tends to dry the skin by absorbing water. It is a solvent of fat and oils. Industrial methylated spirit consists of 95 per cent ethyl alcohol and 5 per cent methyl alcohol. A colouring material and unpleasant tasting substances are added to the liquid to prevent people drinking it. A colourless methylated spirit is sometimes known as "surgical spirit".

Iso-propyl alcohol is a more oily alcohol than the others with a rather unpleasant smell. It has the usual properties of an alcohol. This alcohol is often used as a substitute for the more expensive ethyl alcohol.

Amyl Acetate

A colourless inflammable liquid with an odour of pear-drops or bananas. It is used with acetone as a solvent in the preparation of nail varnish and in some nail varnish removers. It will dissolve celluloid and some plastics.

Carbon Tetrachloride

A heavy colourless non-inflammable liquid with an unpleasant poisonous vapour. It is a solvent of fats and oils. It is used in

some types of oil fire extinguishers. When this liquid comes into contact with hot metals, poisonous fumes of *phosgene* are produced so care must be exercised when using a fire extinguisher containing this liquid.

This solvent is commonly used for removing grease-spots from clothing and for cleaning hair in wig-making. It is ill advised to use this solvent on the hair of a client as the vapour is poisonous.

Chloroform

A heavy, colourless, non-inflammable liquid with a pleasant sweet smell. It is a solvent of fats and oils. It is an anaesthetic. It is used in some setting lotions made from *Gum Tragacanth* as a preservative to prevent the lotion going "mouldy".

XV
SOAPS AND SHAMPOOS

DETERGENT SUBSTANCES

SUBSTANCES that remove grease and oil from contact with surfaces are known as detergents. Grease and oils are normally mixed with dirt particles, thus the importance of removing "dirt grease" units.

Making Soap

The two main types of soap are considered here.

Hard Soap. This type of soap is made by boiling together animal fats or a mixture of fats and oils with sodium hydroxide.

$$\text{Fat} + \text{sodium hydroxide} \longrightarrow \text{sodium soap} + \text{glycerine} + [\text{water}]$$

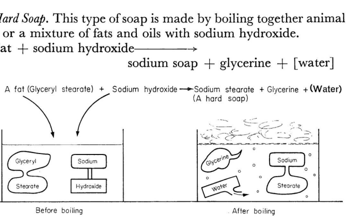


FIG. 69. *Making hard soap.*

This type of soap, the hard soap, has the glycerine removed from the mixture by a process called "salting out"—the addition of salt.

Soft Soap. This type of soap is made by boiling together vegetable oils with potassium hydroxide.

$$\text{Oil} + \text{potassium hydroxide} \longrightarrow \text{potassium soap} + \text{glycerine} + [\text{water}]$$

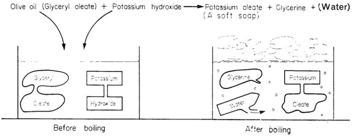


FIG. 70. *Making soft soap.*

This type of soap is *not* "salted out"; the glycerine is left in the soap. Such soaps may be found in vanishing creams and shaving soaps. Liquid soap shampoos consist of a soft soap dissolved in water with a perfume added.

Testing Soap for Free Alkali

A small portion of soap is shaken in warm distilled water until a slight lather is produced. The solution should be tested with a piece of litmus or pH paper. An alkaline soap will give a pH between 7 and 14.

Scum Formation with Hard Water

When soap is used with water that contains calcium salts, the soap will form a compound with the calcium known as calcium soap (*scum*). This scum will not dissolve in water and floats to the surface of the water. No decent lather is obtainable when calcium salts are present in the water without much effort and waste of soap. The calcium salts are removed by methods already described for softening hard water.

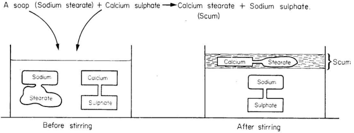


FIG. 71. *Formation of scum.*

Shampoos

Shampoos were originally made from soap-like substances, but are now made largely from substances that imitate the detergent action of the soap molecule. These substances are sometimes called *synthetic detergents*. Shampoos of both types must satisfy many conditions before they can be regarded as good shampoos. A good shampoo must not sting or irritate the skin

when applied. It must not remove too much of the natural oil from the scalp. There are many other conditions such as foam production, conditioning actions, etc.

Shampoos may be classed as: (a) *Soap shampoos* (less popular); (b) *Soapless shampoos* (very popular) synthetic detergent.

(a) *Soap shampoos* are usually made from the "potassium soap" base, together with vegetable oils, etc.

EXAMPLE of a soap shampoo; contains the following:

	per cent
Coconut oil	14
Olive oil	3
Castor oil	3
Potassium hydroxide	4·7
Glycerine	2
Ethyl alcohol	4
Sodium hexameta phosphate	1
Perfume	0·3
Water	68

(b) *Soapless shampoos* are usually made from (1) Triethanolamine lauryl sulphate or (2) Sodium lauryl sulphate or (3) Ammonium lauryl sulphate, together with light oils and perfume.

EXAMPLE:

	per cent
Triethanolamine lauryl sulphate	38
Sodium alginate	2·5
Water	62·5

(4) An alternative to the above synthetic detergents are the shampoos made with *sulphonated vegetable oils*.

EXAMPLE:

	per cent
Sulphonated castor oil	59·5
Sulphonated olive oil	19·5
Mineral light oil	3
Glycerine	3·5
Perfume	0·5

These shampoos are often in the clear liquid form.

Other forms of the detergent are available as below:

(1) *Liquid creme* or creme lotion shampoos. This type of shampoo may have conditioning properties making the hair more lustrous, softer and easier to manage. Such a shampoo may contain dispersed lanolin or egg powder.

(2) *Creme paste* shampoos are a paste form of the synthetic detergent with a little soap present.

EXAMPLE:

	per cent
Sodium lauryl sulphate	50
Sodium stearate	8
Water	4
Lanolin	1

These shampoos may contain egg. This addition was originally made with soap shampoos to overcome hard water.

In modern synthetic detergent shampoos it may have a stabilizing effect on the size of bubble produced during lathering.

(3) *Dry shampoos* are absorbent powders and mild alkalis which slowly absorb the oil and dirt from the hair and scalp. Such powders may be Fuller's Earth, starch or talc. The mild alkali may be sodium bicarbonate and borax.

EXAMPLE:

	per cent
Borax	6
Sodium carbonate	7
Talc	60
Fuller's Earth	17
Perfume	as required

These powders are rubbed into the hair and left for 10–15 minutes. When the powder is brushed out of the hair much of the dirt goes with it.

(4) Liquid *non-aqueous* shampoos contain organic solvents instead of water, such as benzene, carbon-tetrachloride, ethylene dichloride or iso-propyl alcohol. These solvents are not really safe for use on the hair as they are either toxic or inflammable.

They have a further disadvantage in that they are liable to remove too much oil from the hair. This type of shampoo is useful in areas where the water is "hard".

The detergent substance in the shampoo has added to it many other chemicals in small proportions, to give finish, consistency, colour, foam effect, clarity, to preserve from mould growths and to give anti-bacteria action.

The Advantages and Disadvantages of a Soapless Detergent

A soapless detergent *will* produce a calcium salt with hard water, but this salt dissolves in the water and thus does not form a scum.

The soapless detergent is a good wetting agent and removes grease from the hair more effectively.

If the hair is very oily these detergents are of great value. They may make the hair brittle if the client has little natural oil on the hair. Some clients may be allergic to the synthetic soapless detergents.

The Cleansing Action of Detergents

The soap and soapless detergent molecules are similar in that they have two ends with different properties. One end of the molecule is water repellant, the other end of the molecule is water attracted.

When detergents are placed into water the molecules line themselves out along the surface of the water with the repellant ends out of the water.

Stirring the water brings the repellant ends of the molecule under the water.

The water repellant ends will dissolve in grease, so if any grease is present in the water the repellant ends of the detergent molecules will dissolve in it.

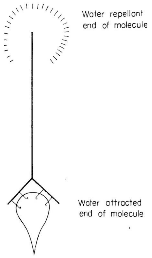


FIG. 72. *Detergent molecule.*

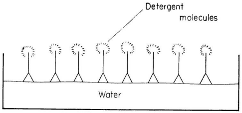


FIG. 73. *Detergent molecules on the surface of water.*

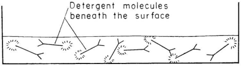


FIG. 74. *Detergent molecules beneath the surface.*

As the detergent molecules surround the grease, so, the grease and dirt are forced apart from the hair.

The detergent is an emulsifying agent. The dirty water contains emulsified fats and oils.

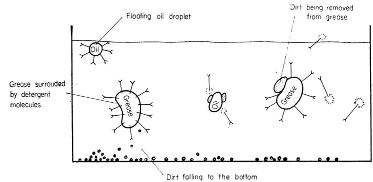


FIG. 75. *Dirt and grease separation.*

HAIR-SETTING LOTIONS AND LACQUERS

Setting Lotions

These lotions are generally emulsions made from gums with water. They are used by ladies and gentlemen to keep the waves in the hair *set*—they do this by making hairs cling together in the required position. A common example is gum tragacanth setting lotion.

	per cent
Gum tragacanth	1·2
Alcohol	10·0
Glycerine	5·0
Water	83·8
Preservative	as required

Hair Lacquers

These are quick drying setting lotions in fact, which originally contained resins dissolved in spirits. The spirits evaporated quickly off the hair leaving behind the resin on the hairs binding them together. *Shellacs* dissolved in alcohol have replaced other resins, some of which cause dermatitis.

Modern lacquers contain a plastic like material known in short as PVP which coat each individual hair, ideally, and consequently lacquered hair may be combed without breaking the set.

N.B. Where the composition of various preparations is included, this is not expected to help in laboratory experiments, but merely to illustrate the component chemicals.

XVI
PERMANENT WAVING

THIS chapter and the following one concern treating the hair either with a waving solution or a colouring agent. It is necessary to consider briefly the chemistry of the hair.

The larger part of the hair is composed of an insoluble protein *keratin*. This protein, like others, is made up of amino-acids in long chains. These long chain molecules are joined together by links of hydrogen, sulphur and different salts.

If the hair is treated with acid solutions of a pH between 1 and 2—the hair swells because both the hydrogen and salt links are broken. The hair remains intact because the sulphur links are still present.

If the hair is treated with an alkali solution of pH 10 swelling again occurs for the same reasons, but if the pH is increased to 12 then the hair dissolves because the sulphur links also are broken.

Permanent waving is a controlled breakdown of some of the linkages holding the hair intact.

Some Properties of the Hair

The hair is *hygroscopic*, that is it absorbs moisture from the atmosphere, it becomes slightly thicker and longer in doing so. The hair is also elastic and can be stretched about one-third of its length—it will stretch more in cold water, and even further in steam. The addition of alkalis to the water softens the hair.

The addition of *reducing agents* as well as alkalis allows the hair to be waved in cold solutions. In *Cold-wave lotions* ammonium thioglycollate is usually the reducing agent. In *Hot-wave lotions* sodium sulphite may be the reducing agent.

THE THEORY BEHIND WAVING

When a hair is stretched the internal structure of the hair molecules is distorted. Similarly when a hair is curled tightly

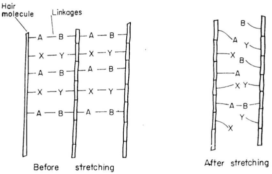


FIG. 76. *Stretching the hair.*

around a curler the molecular structure of the hair is distorted. If this distortion is produced on wet hair which is then dried, the curl will remain for a short time; until re-wetted. This is not a permanent wave.

A permanent wave may be obtained by curling a hair which is exposed to steam or boiling water. The heat of the steam breaks the so-called *cystine* (sulphur linkages) linkages between the long hair molecules.

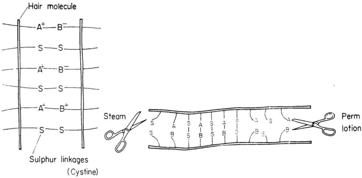


FIG. 77. *Breaking the linkages.*

This rupture of the linkages must be "mended" or new linkages must be formed if the hair is going to be permanently changed in form. This takes place under the action of steam and air, but later perm-treatments employ neutralizers for this purpose.

Permanent wavings are grouped as follows: (a) Heat permanent waving; (b) Cold permanent waving; (c) Tepid waving.

(a) *Heat Permanent Waving*

Permanent wave formation of this type is based upon the principle of re-arranging the molecular structure of the hair by the following method:

The cuticle of the hair is softened by means of a reducing agent such as sodium sulphite and an alkali such as ammonia; this allows the hair to be stretched into a new formation, such as occurs when wound on a curler. The sulphite ruptures some of the sulphur linkages.

The new molecular structure of the hair is fixed by means of a heater. The source of heat may be an electrical element or a calcium oxide (quicklime) chemical pad.

The success of this method depends upon the correct strength of permanent waving solution, the proper winding technique and the correct temperature of the heaters.

(b) *Cold Permanent Waving*

This method employs only perming solutions. Before commencing this method it is necessary to note whether the hair has been tinted or permed before; if it has then a reduced strength of perm solution is necessary. The hair is shampooed with an *ordinary* soapless shampoo and then towel dried (or dried as manufacturers recommend for their particular perm-solution). The hair is rolled over curlers, but it must not be too tight otherwise it may break when the solution is applied. The reason for this possible damage is because the perm-solution which generally

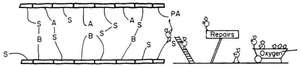


FIG. 78. *The "neutralizer" (oxidation).*

contains a reducing agent *ammonium thioglycollate*, softens the hair. As this softening is taking place the cystine molecules of the hair shaft are *reduced* or broken down into *cysteine* molecules. This

chemical breakdown will continue for some time unless water is put on to the hair. An acidified solution of hydrogen peroxide—"*the neutralizer*"—is put on to the hair to supply oxygen that allows the broken molecular linkages to convert back to cystine.

The hair is then "set" in the new formation. Some neutralizers contain foaming agents which help the penetration of the oxygen. Many such neutralizers contain conditioners which return the hair to a healthy state.

FIG. 79. *Precautions are necessary.*

Certain precautions are necessary when cold-waving.

1. The solution of ammonium thioglycollate should not be allowed to have a pH of more than 9·5 otherwise it may not only burn the scalp but also act as a depilatory.

2. As much as is possible the cold-wave solution should not be allowed to come in contact with the scalp. This is easier when a cream preparation is used.

3. The hair must never be pulled when the cold-wave solution is on the head, the hair may be damaged or removed.

4. If an assistant is using cold-wave preparations very often then the hands should be covered with rubber gloves. On single occasions a covering of barrier cream is advisable.

(c) *Tepid Permanent Waving*

This system employs both heaters and cold-wave solutions. The heat used is much reduced and the strength of the cold-wave solution is reduced.

The cold-wave solution produces a partial breakdown of the *cystine* molecular linkage. The permanent wave is completed by means of winding and heating as in the normal heat perming.

This method eliminates the disadvantages of the heat and cold-wave systems.

Temporary Waving

As with the cold-wave method, here also it is necessary to commence work on a head thoroughly washed with an *ordinary* soapless shampoo. The hair is towel dried and set. The temporary perm solution is applied to each curl. In some cases the solution is combed through the hair. This solution softens the hair. It is left on the hair for whatever length of time the manufacturers may recommend. The hair takes up the form of the set, but has to be hardened into this formation. This is achieved by drying the hair rapidly under a hot dryer. The set that results will last for about eight weeks depending on the type of hair. (Brush wave.)

Straightening Hair

In order to straighten the hair it is necessary to reverse the perming procedure. The reagents employed are the same.

XVII
HAIR COLOURING

HAIR colourings may be grouped into the following classes. The basis of this classification is the ability of the colouring to withstand shampooing.

Class I — Permanent colourings
- (i) Vegetable tints
- (ii) Vegetable mineral tints
- (iii) Mineral (metallic) tints
- (iv) Oxidation tints

Class II — Semi-permanent colouring

Class III — Temporary colourings (rinses)

CLASS I—PERMANENT COLOURINGS

(1) *Vegetable Tints*

This type of powdered vegetable tint is not as popular as it used to be because of the complex and lengthy procedure involved in producing a colour. More recent products are far more convenient to produce the same result. Such vegetable tints are *Camomile*, which due to its yellow pigment, gives a lightening effect to naturally fair hair.

Henna is another vegetable tint which may be used to give tints from brown to red. The application of henna to the hair is a skilled operation taking a comparatively long time to complete.

(ii) *Vegetable Mineral Tints*

This type of tint is a mixture of a metal salt such as silver with ordinary henna; known then as a *compound henna.* The method of application is the same as for ordinary henna. The black metal oxide, such as silver oxide is coated on the hair. It takes some hours before the atmosphere oxidizes the colour to its final shade. A disadvantage of this type of tint, apart from the lengthy process of preparation and application, is the fact that special precautions have to be exercised if the hair ever needs bleaching or perming, to prevent damage to the hair.

(iii) *Mineral (metallic) Tints*

This type of tint was known as a "two application tint". This type of dye forms a metallic coating over the hair-shaft —this gives the hair a characteristic dull metallic appearance. The hair becomes unsatisfactory for permanent waving, bleaching or tinting after the use of metallic salts on the hair. These salts must be removed from the hair shaft before any attempt at tinting, bleaching or perming. The most frequent metallic dye is a compound of lead which gives the hair a darkish shade.

(iv) *Oxidation Tints*

This group of colourings is nearly always now based upon the *para-dyes*. The two common para-dyes are:

(a) *para-phenylene-diamine* (giving blackish colours).
(b) *para-toluylene-diamine* (giving brownish colours).

The colourings may be in liquid or cream form. The colour of the preparation may not resemble the colour required for the hair. The coloured molecule of the para-dye is formed as follows.

The preparation is applied to the hair with 20 or 30 volume hydrogen peroxide. The small, sometimes colourless dye molecules enter the hair shaft with the oxygen given off from the

hydrogen peroxide. The small molecules increase in size when inside the hair due to oxidation by the oxygen; large coloured molecules are now formed. These coloured molecules are now too large to be removed from the hair by shampooing.

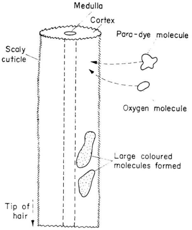


FIG. 80. *Oxidation tint (a permanent colour).*

This type of colouring chemical is known to cause skin irritations for some people, thus a precautionary test must *always* be carried out before use.

A small amount of the dye is rubbed behind the ear lobe and covered for 48 hours. If an irritation or rash does result then that client must never have a permanent colouring with a para-dye preparation.

These dyes are permanent but they do have a tendency to fade, particularly in sun light, thus it is occasionally necessary to comb the dye/peroxide mixture through the fading parts of the hair.

CLASS II—SEMI-PERMANENT COLOURINGS

This class of colouring will be removed from the hair after 5 or 6 shampoos. The small colour molecules enter the hair-shaft and are held there by a physical or chemical link. The colour is resistant to water alone.

Many of the semi-permanents are shades of golden, brown or auburn and are intended for use on naturally coloured hair. The medium for this colour is commonly the colour shampoo.

A new series of semi-permanent colours has been developed which will produce a wide range of colours on white or bleached hair. A full range of the more exotic colours may be produced by this new series of dyes. Together with the colouring agent is a carrier by means of which the dye is brought into close contact with the hair.

CLASS III—TEMPORARY COLOURINGS

This class of colourings ideally should be resistant to water alone but easily removed by one shampoo. The colour molecules enter the hair-shaft and are held there by a physical or chemical link, as are the semi-permanents. On some occasions the colouring may coat the outside of the hair. This produces a dull appearance. A disadvantage of the temporary colourings is the possibility of the colour running in a rain shower or being rubbed out by brushing.

Since the majority of these rinses only coat the hair, they are not affected by the internal condition of the hair (effect of perming, bleaching, etc.).

Practical Notes Connected with Hair Colouring

1. Bleaches and dyes will "take" much more rapidly if the temperature of the hair is increased. Less damage is done to the hair the quicker the process of bleaching and dyeing takes place,

These increased temperatures for bleaching and dyeing may be obtained by using the *steamer*.

2. Permanent colourings make the hair more receptive to permanent waving, thus certain precautions such as diluting the cold-wave solution may be necessary.

3. In general it is advised that perming be carried out first and colouring done a day or two later, rather than perming after a colour.

Removal of Hair Dyes

If a mistake is made it may be necessary to remove some of the dye or to lighten the shade. The oxidation tints may be removed fairly successfully with a reducing agent such as sodium hydrosulphite (5 per cent solution). (Reducing agent—see Glossary.)

The semi-permanent dye may be removed by much shampooing in the presence of a little ammonia. The coating of temporary rinses may sometimes prove difficult to remove in a hurry, especially if they are dissolved in plastic solutions.

The metallic dyes are best allowed to grow out of the hair, the hair then being cut off.

Platinum Blonde

The platinum blonde is produced by rinsing the normal bleached head with a 1:100,000 methylene blue solution. A slightly bluish hair appears whiter.

XVIII
ELECTRICITY

THREE methods of making electricity are to be considered.

(a) Electricity by friction (rubbing).
(b) Electricity by chemical reactions.
(c) Electricity from magnetism.

STATIC ELECTRICITY

When certain materials rub together a form of electricity is made. This electricity is called *Static electricity*. When objects rub together *friction* takes place. Thus static electricity is made when friction occurs between certain solid objects.

Demonstration of Static Electricity

A rod of a hard material called *Ebonite* is rubbed briskly across a piece of rabbit fur. The friction between these two surfaces makes static electricity in the ebonite rod. This electricity allows the rod to pick up or attract small pieces of paper.

A ball-point pen rubbed on a nylon overall will produce static electricity. Static electricity occurs when a bakelite comb is vigorously pulled through the hair. The comb will attract particles of dust. A nylon brush will stick to the hair if brushed firmly across clean, washed hair.

Certain items of clothing become "electrified" due to the constant friction of one piece of clothing against another.

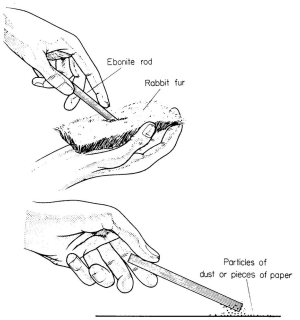


FIG. 81. *Static electricity.*

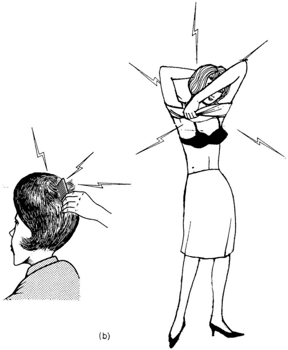


FIG. 81b. *Static electricity*

CHEMICAL ELECTRICITY

When certain chemicals react together electricity is made (generated). This type of electricity is given out by simple torch cells and accumulators.

A *cell* is a portable source of electricity. Many cells together are called a *battery* (of cells). There are two types of cell.

The *Primary cell* is a portable source of electricity, the electricity being generated within the cell as a result of chemical

reactions. Such cells are the familiar "batteries" in torches or radios.

These cells generate their own electricity.

The *Secondary cell* is a portable source of electricity but the electricity is *stored* within the cell in the form of certain chemicals. The electricity is in fact "second-hand". It is put into the cell from the mains after passing through a charging unit, the cell is then "charged". Such cells are the accumulators, commonly referred to as "batteries" in cars, etc.

Primary cells

One of the earliest forms of chemical cell was the *simple voltaic cell* such as is described below. A later cell called the *Leclanché cell* is the forerunner of modern torch batteries.

Demonstration of Chemical Electricity—the Simple Cell.

Into a small glass tank three parts full of dilute sulphuric acid, two plates of metal with connecting wires are placed. One metal plate is copper, the other zinc.

The zinc plate is immediately, "eaten" away by the acid and bubbles of impure hydrogen can be seen to come to the surface of the acid.

If two wires are attached to a *voltmeter* an electrical pressure of approximately 0·9 volts is seen to be generated by the cell

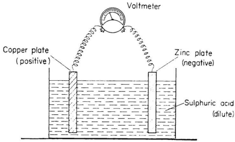


FIG. 82. *A simple cell.*

This cell was invented by a scientist called *Volta,* thus the names Voltaic cell, volts, etc.

The electricity in the cell is made because the following chemical reactions take place (very briefly).

The *zinc plate* becomes negative because zinc is eaten away by the acid, thus the zinc plate is "*minus*" zinc—that is negative.

The *copper plate* becomes positive because the hydrogen bubbles from the acid gather around it, thus it "gains" hydrogen—that is it is positive.

After a length of time the voltage of this cell will drop below 0·9 volts. This drop in electrical pressure is due to the copper plate becoming smothered in hydrogen bubbles. This is *polarization.*

Depolarization is the removal of these hydrogen bubbles by letting the cell stand awhile or by adding some chemical to the cell.

Useful words—*Electrodes:* This is the name given to the plates or rods that stand in the liquid. *Electrolyte:* This is the name of the liquid in which the electrodes stand. An electrolyte is a liquid which will conduct electricity.

The Leclanché Cell, a Later Type of Chemical Cell

This type of cell is rarely found outside the laboratory. It is the forerunner of the ordinary battery.

The Electrolyte—a saturated solution of ammonium chloride.

The Electrodes—zinc rod (negative) carbon rod (positive).

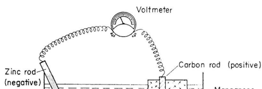


FIG. 83. *The Leclanché cell.*

Chemical Reactions going on inside the Cell

(a) When a solid or liquid dissolves, the molecules break up into parts which become negative or positive. These negative or positive parts are called *Ions*. This process of breaking up into ions is called *Ionization.*

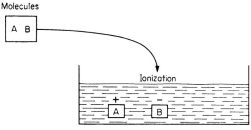


FIG. 84. *Ionization.*

Ammonium chloride *ionizes* as follows—

Ammonium chloride——→ ammonium ions + chloride ions

Molecules ————→positive ions + negative ions.

It is the presence of ions in a solution that allows it to conduct electricity. Thus an electrolyte is in a state of ionization. It is the ions which react in these chemical cells.

(b) The zinc electrode loses zinc particles (ions) and becomes "minus" zinc, that is negative.

The carbon rod gains hydrogen from the ammonia and becomes positive.

It is this movement of ions which is known as an *electrical current*.

(c) The porous pot in the cell contains manganese dioxide which combines with hydrogen gathering around the carbon

rod. The hydrogen is changed to water to prevent it from causing polarization. Thus the manganese dioxide is known as the depolarizing agent in this cell.

Practical disadvantages of this cell are that it tends to polarize quickly as the manganese dioxide cannot convert all the hydrogen to water quickly enough. The use of liquids is also a disadvantage for practical purposes.

The Dry Cell—An Adaptation of the Leclanché Cell

The actions inside the dry torch battery are identical to those taking place in the Leclanché cell. The major difference between the two cells in terms of structure is that the electrolyte in the dry cell is in paste form.

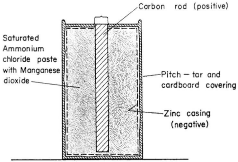


FIG. 85. *A dry cell.*

The Electrolyte—a saturated solution of ammonium chloride in paste form with Plaster of Paris.

The Electrodes—The zinc case acts as a negative electrode enclosing the electrolyte. The carbon rod is the positive electrode.

The whole cell is generally covered with pitch except for a small hole which allows gases such as ammonia to escape.

Chemical Reactions inside the Cell

The activity inside the cell is identical to that which takes place inside the Leclanché cell.

The carbon rod becomes positive due to its gaining hydrogen.

The zinc casing is negative because it loses zinc. Manganese dioxide acts as a depolarizing agent.

The *disadvantages* of the dry cell are that it is exhausted when the ammonium chloride is finished. It cannot be recharged.

The *advantages* of this cell are that it may be easily transported and no liquids are required for its functioning.

SECONDARY CELLS

The secondary cell is one which accumulates or stores electricity which has already been fed into it from the mains.

The Accumulator

The Electrolyte. Dilute sulphuric acid (in distilled water).
The Electrodes. Lead grids filled with a paste of lead oxide.

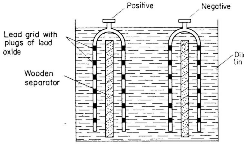


FIG. 86. *A lead accumulator.*

The activity inside the accumulator is a complex one, best understood by noting what happens when it is charged or discharged.

Charging an Accumulator

An accumulator is charged by passing d.c. mains from a charging unit through the lead plates. The positive wire from the charging apparatus is attached to the positive pole of the accumulator. The negative wire is attached to the negative pole of the accumulator.

Note: The current from the mains must be lowered by adding a resistance in the charging circuit.

The accumulator is known to be charged when (a) the specific gravity of the sulphuric acid rises to 1·21 and the voltage of the cell reaches 2 volts. (b) gas bubbles are given off at the plates. During charging electrical energy is converted into chemical energy.

Discharging an Accumulator. (The accumulator in use.)

When an accumulator is being used the chemical energy stored in the lead plates is converted back to electrical energy.

During discharging the specific gravity of the accumulator acid drops. The cell should never be used when the acid specific gravity is falling below 1·18 and the voltage is below 1·8 volts.

Output of an Accumulator

The output of an accumulator is measured in terms of the number of hours it can be used to give out 1 ampere.

e.g. 12 ampere hours, means the cell can give out 1 ampere without the pressure dropping for 12 hours.

The *disadvantages* of an accumulator are the heaviness of the cell due to the lead plates. The lead plates make the cell expensive. The acid electrolyte is a possible danger.

A more convenient modern accumulator is the Nickel-ion accumulator. This accumulator is not so heavy as the lead accumulator.

Using More than One Cell at a Time

If two or more cells are being used at once they may be joined together by means of connecting wires in two different ways.

(a) Negative to negative, positive to positive. This is called *Parallel wiring*.

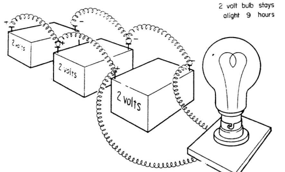


Fig. 87. *Cells in parallel.*

When cells are joined together in this way they may be used for three times as long as a *single* cell, but the *same* voltage is supplied as one cell.

(b) Negative to positive. This is called *series wiring*.

When cells are joined together in this way the voltage of each cell is added (e.g three 2 volt cells = 6 volts) but the length of time they may be used is the same as one cell.

The wiring of cells in this way is of no practical importance for hairdressers, but demonstrates the principle that the method of wiring apparatus together does make a difference.

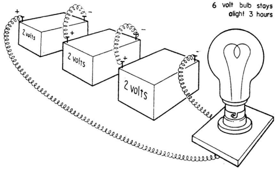


FIG. 88. *Cells in series.*

DYNAMO ELECTRICITY

Electricity made by chemical reactions has a very low voltage and is thus of little use for running any heavy apparatus such as a

FIG. 89. *Electricity across country.*

drier or electric fire. Electricity produced in power stations comes from dynamos and is of very high voltage. The high voltage electricity from the power station must pass through a series of step-down transformers before being used in the salon.

Electricity from the dynamo is produced by rotating a coil of wire between the opposite ends (poles) of magnets.

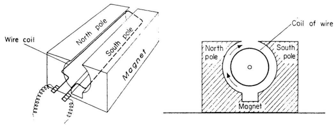


FIG. 90. *The principle of the dynamo.*

In order to understand why this makes electricity it is necessary to know something about magnets.

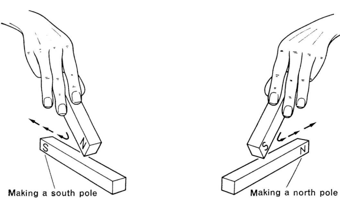


FIG. 91. *Making a magnet by stroking.*

Magnets and Magnetism

(i) Magnetism is a natural property found in the rock called *Lodestone*.

(ii) Magnets have a tendency when suspended by a thread to hang in a north-south direction (e.g. a compass needle).

(iii) A steel bar may be made into a magnet in two ways:
By stroking the bar with another magnet.
By passing an electric current through a wire coiled about a steel bar.

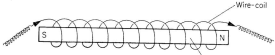


FIG. 92. *An electromagnet.*

(iv) Magnets may be destroyed:
By banging or dropping on a hard surface.
By heating the magnet in a flame.

(v) The north pointing end of a magnet will push away another north pointing end.

Like poles repel. The north and south pointing ends will come together.

Opposite poles attract.

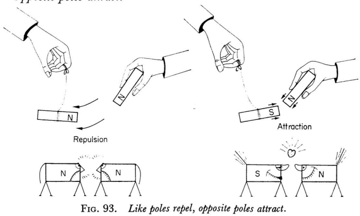


FIG. 93. *Like poles repel, opposite poles attract.*

(vi) Magnets are surrounded by a "*Magnetic field*". If a bar magnet is placed beneath a piece of glass on which lies a sheet of white paper, the magnetic field around the magnet may be shown in the following way. Iron filings are sprinkled onto the white paper from a height of two or three feet to ensure an even distribution of the filings.

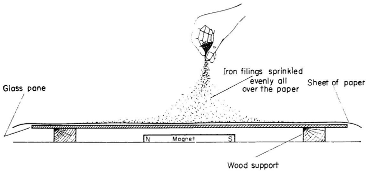


Fig. 94. *Demonstrating lines of force.*

When the filings are coating the paper a gentle tap with a pencil on the glass will cause the filings to trace out the magnetic field surrounding the magnet.

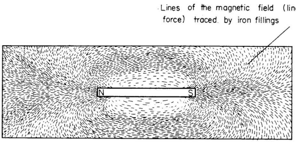


Fig. 95. *The lines of force.*

Making an Electrical Impulse in a Wire

When a wire moves across the lines of force surrounding a magnet, a small electrical impulse is created (or *induced*) in the wire.

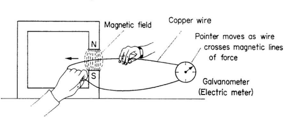


FIG. 96. *Inducing an electrical impulse in a wire.*

Similarly this impulse is created if a magnet is plunged into a coil of wire.

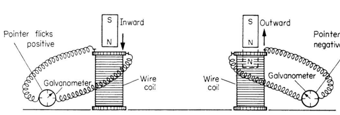


FIG. 97. *Creating an alternating impulse.*

As the magnet is pushed into the coil of wire a current is set up in the wire. This is shown by a flick of the meter needle. When the magnet is withdrawn another impulse is set up and the needle flicks the other way. This back and forth movement of the impulse is called an *alternating current* (a.c.).

Making an Electrical Current by Means of a Dynamo

Breaking the magnetic lines of force by means of a wire is the basis of the dynamo's functioning. Great lengths of wire are coiled about a framework on a spindle and spun at high speed between the poles of a magnet.

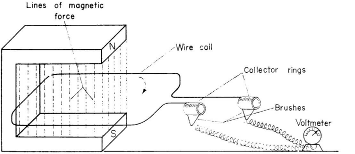


FIG. 98. *An a.c. dynamo.*

The coil is made to spin between the poles of the magnet by having the spindle fitted with a propeller or water wheel. This propeller may be turned by high pressure jets of steam being directed at the blades. This is then known as a *steam turbine*. The water wheel may be turned by water falling over a water fall. This is how a hydro-electric power station works.

As the coil spins, it breaks across the lines of force. It does so twice on each revolution, so an alternating impulse, negative then positive, is produced.

Such a dynamo is known as an *a.c. generator*.

In order to prevent this back and forth movement between negative and positive, the dynamo is fitted with *split-ring commutators* and *brushes*. Such a dynamo is known as a direct current (d.c.) generator. The direct current does not change negative to positive many times per second as does the alternating current.

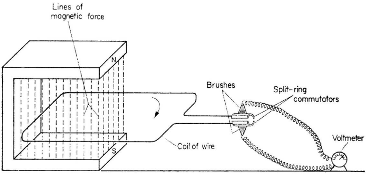


FIG. 99. *A d.c. dynamo.*

Compare the dynamo with the electric motor.
Dynamo—mechanical energy put in to create electricity.
Electric motor—electricity is put in to create mechanical power for driving machinery (see later).

THE ELECTRICAL CIRCUIT

When an electric current is flowing through a wire then it is said that the electrical *circuit is complete*. If no electricity is flowing through a wire then the circuit is said to be *broken*.

Experiment. Setting up a make and break circuit.

When the morse key is pressed down and the light goes on, then the circuit is known as complete. When the morse key is raised the light goes out and the circuit is known as broken.

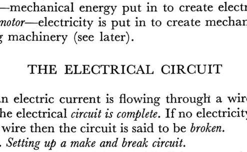


FIG. 100. *A make and break circuit.*

The Circuit in the Salon

The wires which make up the circuit for driers, etc., are usually concealed behind the wall plaster and contained in steel tubes called *conduit tubing*. The wires are contained in such a tubing to prevent any danger of overheating of wires causing a fire or workmen cutting the wires during building operations, etc. The make and break of the circuit takes place at the switch, either the wall switch or the hood switch of the drier.

The Ring Main Circuit

If many pieces of electrical apparatus are going to draw upon the electric circuit for power, then a fairly recent and safe wiring method is employed, called the *ring main circuit*. This method employs in fact, two rings of wire, one neutral, the other live. The live wire passes through a 30-amp fuse to prevent overloading. Study the layout of this method in the diagram below.

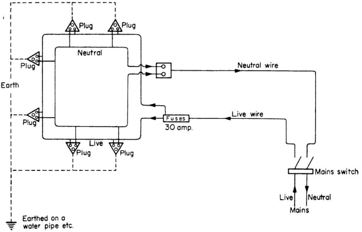


FIG. 101. *A ring main circuit.*

This circuit may have as many as twenty sockets placed at convenient places in the salon. The wall plugs used generally have a suitable fuse in the plug head as an added precaution.

Using More than One Piece of Apparatus at a Time

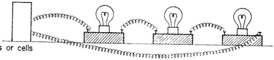


FIG. 102. *Lamps in series.*

Connecting Lamps in Series

When lamps or other pieces of apparatus are connected together as shown above, then any breakage in the circuit will cause all the lights to go out. This may be shown by removing one bulk from its socket, the other lights will be extinguished.

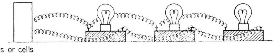


FIG. 103. *Lamps in parallel.*

Connecting Lamps in Parallel

When lamps or other pieces of apparatus are connected in *parallel*, then if one or two bulbs are removed, the circuit is *not* broken.

The *lighting circuit* in the salon will normally have the lamps joined in parallel so that if one lamp becomes defective all the lamps will not go out as they would do if joined in series.

The fan motor and heater of the hairdrier are wired in parallel so that each may be operated independently of the other.

Conductors and Insulators of Electricity

(a) *Conductors* are materials which offer little resistance to electricity and thus conduct an electric current.
EXAMPLE. Metals are the best conductors of electricity. Silver is the best conductor, but copper is the most commonly used for wiring purposes. Water and solutions of salts or acids conduct electricity and are known as *electrolytes*.

(b) *Insulators* are materials which will not conduct electricity.
EXAMPLES. Rubber, porcelain, wax, mica, ebonite, bakelite, plastic, asbestos.

Insulators are necessary on electrical apparatus to prevent the user from getting a shock. Handles or any other part frequently handled should be well insulated. Cables and wires that lie next to inflammable materials are usually insulated to prevent possible fires. If wires become exposed where they join the plugs or pendant switches on hairdriers, take off the plugs and cut back the wire. Insulating tape should only be used as a temporary measure.

Measurement of the Electric Current

Electricity flowing in a conductor is measured in units called *volts* and *amperes*:

Volts—the pressure of electricity;

Amperes (amps)—the amount of electricity (rate of flow).

In order to understand the difference between the two terms a comparison between water flowing in a pipe and electricity flowing along a conductor is useful.

In the sketch below, the two people are directing hose pipes of different cross sections into the air.

(i) The height to which both hoses will squirt depends upon the pressure of the water leaving the hose, whatever the cross section may happen to be.

This pressure or "squirting power" may for simplicity be regarded as the same as the voltage of an electrical current.

(ii) The amount of water which comes from the hoses will depend upon the cross section of the hose.

The amount of water may be regarded as the same as the amperage of an electrical current.

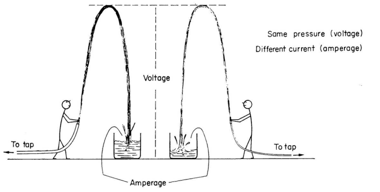


Fig. 104. *Amperage and voltage.*

To detect the presence of electricity a clock-like instrument called a *galvanometer* is used.

To measure the voltage of an electrical current a *voltmeter* is used.

To measure the amperage of an electrical current an *ammeter* is used.

The Resistance of Conductors to Electricity

If electricity passes along a conductor with great difficulty (because of length, thickness or type of metal) then electricity makes that conductor hot. A conductor along which electricity passes with difficulty is said to offer a *resistance* to electricity. This resistance is measured in units called *Ohms*.

If the voltage and amperage of a current is known, the resistance of a conductor may be calculated, because:

$$\text{(Resistance) Ohms} = \frac{\text{volts}}{\text{amps}}$$

EXAMPLE. What is the resistance of the following—a 5 amp current at 200 volts?

$$\text{Ohms} = \frac{200 \text{ volts}}{5 \text{ amps}} = 40 \text{ ohms}$$

Changing this formula around a little it is possible to calculate:

$$\text{(Current) amps} = \frac{\text{volts}}{\text{ohms}} = \frac{200 \text{ volts}}{40 \text{ ohms}} = 5 \text{ amps}$$

$$\text{(Pressure) volts} = \text{amps} \times \text{ohms} = 5 \text{ amps} \times 40 \text{ ohms} = 200 \text{ volts}$$

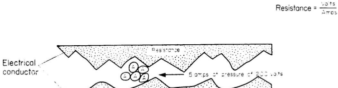


FIG. 105. *5 amps at 200 volts.*

Exercise. Find the resistance in the following cases.

(a) 5 amps at 240 volts.
(b) 5 amps at 250 volts.
(c) 15 amps at 200 volts.
(d) 15 amps at 240 volts.

Applications in Hairdressing

High resistance wires are used in heating elements, thus the passage of electricity is responsible for the heat generated.

White heat is produced in electric bulbs.

The switches which control the motor speed on the hairdrier consists of resistance wire of varying resistance, thus allowing through a certain current. These switches are known as *rheostats.*

The Power Being Used in the Salon

The power being used to run hairdriers, etc., in the salon is calculated by the electricity meter. The electricity bill depends upon:

(i) The amperes being used.

(ii) The voltage of the current.

(iii) The number of hours both are being used.

The power of electricity is determined by multiplying volts and amperes.

Power = volts × amperes = watts.

The power of electricity is measured in *watts.*

Examples. (a) The power supplied by an electrical socket of 5 amperes, 200 volts is as follows:

5 amps × 200 volts = 1000 watts (1 kilowatt)

(b) The power supplied by an electrical socket, 15 amps, 250 volts is as follows:

15 amps × 250 volts = 3750 watts.

The electricity meter is a *kilowatt meter*; it multiplies kilowatts of power by the number of hours used.

1 kilowatt used for an hour is a *kilowatt-hour* (kWh)

1kWh = 1 unit of electricity.

Electricity is paid for by the unit.

Example. A 2000 watt electric fire is running for 8 hours per day for 6 days a week. How much does this cost per week when 1 unit of electricity costs 2*d.*?

2000 watts for 8 hours = 16,000 watt-hours (16 kWh)
16 kilowatt-hours for 6 days = 96,000 watt-hours (96 kWh)
96 kWh is 96 units at 2*d.* per unit
96 × 2*d.* = 192*d.* = 16 shillings.

The cost of running this fire would be 16*s.*

EXERCISE.

(1) Obtain from your local authority the standard tariffs for a supply of electricity to a salon. Obtain also some information explaining how to read the electric meter.

(2) Calculate the costs of using the following, assuming electricity to be 2*d* per unit: (a) A 2 kilowatt heater, a 750 watt T.V. set and a 250 watt light are used for 5 hours per day for 5 days per week. (b) A pair of 2 kilowatt heaters, a 2000 watt electric fire and ten 100 watt standard lamps are used for 4 hours per day for 5 days per week.

Reading the Electric Meter

In order to be able to determine the running costs of appliances in the salon from one week to the next, a record of the number of units used per week should be kept on a card hanging by the electric meter.

The meter is read as below:

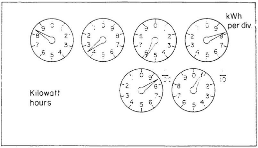


FIG. 106. *An electricity meter.*

The dials register thousands, hundreds, tens and single units (kilowatt-hours). The dials registering tenths and hundredths may be ignored; they are used for testing purposes. The pointer goes clockwise and anticlockwise alternately. Start reading from the left and always write down the nearest lower figure. When the pointer is *on* a figure (say 6), then 5 is written down unless the hand on the next dial on the right is between 0 and 1.

THE EFFECTS OF AN ELECTRIC CURRENT

(a) Heating effects.
(b) Chemical effects.
(c) Magnetic effects.

(a) The Heating Effects of an Electric Current

When an electrical current passes along a wire of high resistance, heat is generated.

Experiment. To demonstrate that heat is generated by an electric current.

Two insulated copper connecting wires are attached to the two terminals of an accumulator. The ends of these wires are connected to a coil of *Eureka* wire.

As the current passes through this coil of high resistance wire it glows red-hot. On this principle are based the heating elements of the hairdrier, electric fire, etc.

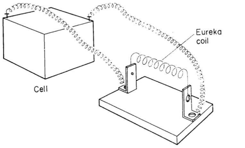


Fig. 107. *Heating effect on an electric current.*

Some Applications of the Heating Effect in the Salon

Hairdriers have a heating element of high resistance wire. The number of elements in operation will depend upon the heat required. The heat is controlled by hand switches or by means of an electrical thermostat in the hood. A fan is present in the hood to blow the warm air over the hair.

Electric irons have a heating wire of *nichrome* sandwiched between *mica* sheets, for insulating purposes.

Electric fires have a high resistance wire coiled about an insulating, non-inflammable bar. The wire glows red-hot when electricity is passing. The heat is usually reflected outwards by means of a silvery curved reflector.

Electric lamps have a very thin high resistance wire made of tungsten which glows white hot when electricity is passing through it. The higher the wattage, the brighter the light.

The air surrounding the filament is usually removed so that the wire does not become oxidized and thus produce a duller light. In place of air in the bulb there may be a partial vacuum or nitrogen gas.

Fuse wires are wires placed at various points in the electrical circuit so that any "overloading" that may take place will not cause the ordinary wires to "glow" and cause fires. If the current in the wire becomes too heavy then the fuse wire will melt; this will cause a broken circuit and no more current will flow.

A fuse wire is made of a mixture of tin, lead and copper.

Experiment. To demonstrate that short circuiting will overload a fuse wire.

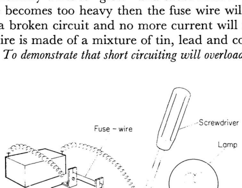


FIG. 108. *Blowing the fuse.*

An accumulator is connected up in the manner shown.

If the metal rod is laid across the bare wires then the current will pass across it and return to the cell, thus *short circuiting* or missing out the lamp. This rapid return to the cell will permit too great a current to flow out of the cell. The excess current will "blow" the fuse, that is the fuse will melt due to the heat produced.

Overloading

Overloading means too much electricity is being carried on a particular circuit thus causing the wires to become hot and blowing the fuse.

An example of overloading.

An apprentice plugs into a 5 ampere, 240 volts wall socket the following pieces of apparatus, using an adapter.

Two 1 kilowatt electric fires.

Three 100 watt electric lamp standards.

This apparatus will require 2×1000 watts $=$ 2000 watts
3×100 watts $=$ 300 watts

2300 watts

The power supplied by the plug socket is

(volts $\times$ amperes $=$ watts)

240 volts $\times$ 5 amperes $=$ 1200 watts

The apprentice is attempting to obtain 2300 watts from a circuit only designed to carry 1200 watts. This is overloading and will blow the fuses.

Practical Notes for the Salon

(i) Frayed wires are dangerous not only because of their liability to cause a "shock", but also because they are liable to cause a fire if left lying in contact with inflammable materials.

(ii) Loose contacts in plugs or at the point of connection to some appliance may cause burning or short circuiting if ignored.

(iii) The heat generated by electric light bulbs may cause inflammable shades or clothes resting on the shades to smoulder or burn.

(b) THE CHEMICAL EFFECTS OF AN ELECTRIC CURRENT

Salts or acids dissolved in water are *ionized* (i.e. the molecules are broken up into parts called *ions*, which have a negative or positive charge).

e.g. Table salt in water ————→salt solution

$+$ $-$

Sodium chloride $\xrightarrow[\text{ionizes}]{\hspace{3em}}$ sodium and chlorine

Such a solution containing ions is called an *electrolyte*, because it will conduct electricity.

When an electric current is passed through an electrolyte a process called *Electrolysis* takes place.

Experiment. To demonstrate electrolysis of water.

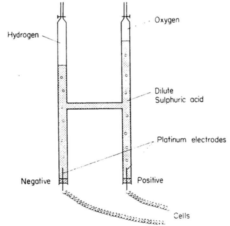


FIG. 109. *Electrolysis of water.*

The apparatus used for this experiment is the *voltameter*.

Into the voltameter with the water a little dilute sulphuric acid is added. This is used because water alone is a poor conductor of electricity. Two accumulators are attached in series to the platinum electrodes. As the electricity passes through the solution bubbles of gas are given off from the electrodes.

Later, one arm of the voltameter will be seen to contain twice as much gas as the other arm. Water is composed of 2 atoms of hydrogen to every 1 atom of oxygen, thus H_2O.

$$\text{Electrolysis} \quad H_2O \longrightarrow 2H + [O]$$

This process of electrolysis has split up the molecule of water into hydrogen and oxygen.

Applications in the Salon

(i) Electrolysis is the basis of a process used by some beauty salons for the removal of unwanted hair. This process may be painful if not performed by an expert. An electrical needle is pushed to the base of a hair follicle. The hair is killed by this method.

(ii) Although pure water is a bad conductor of electricity, the water in the salon will contain dissolved substances and will therefore be a conductor. Thus, no electrical instrument should be used whilst the operator or client is in contact with water.

(c) THE MAGNETIC EFFECTS OF AN ELECTRIC CURRENT.

When an electrical current is passing through a conductor, that conductor becomes surrounded by a magnetic field. This may be demonstrated in the following way.

Experiments. To demonstrate that a magnetic field is created by the flow of electricity in a conductor.

(i) A wire with electricity flowing along it is allowed to pass through a piece of card on which are sprinkled some iron filings.

The iron filings arrange themselves in the magnetic field as shown above.

(ii) A coil of wire with electricity flowing along it will be seen to cause a movement of a compass needle, if the needle is moved from one end of the coil to another.

(iii) If a steel bar has a wire closely coiled about it and electricity is then passed along that wire, the steel bar becomes a magnet, an *electromagnet.*

The steel bar is only a magnet when the current is flowing, thus it will only attract the iron filings when the circuit is complete.

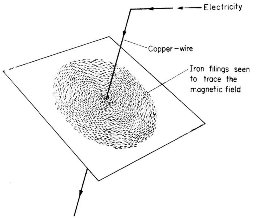


FIG. 110. *Magnetic field round an electric wire.*

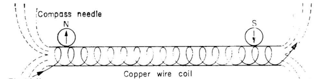


FIG. 111. *Magnetic field round a coil.*

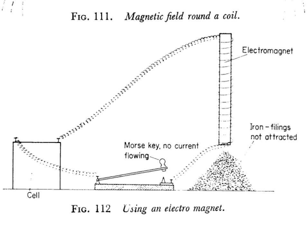


FIG. 112 *Using an electro magnet.*

Practical importance in the Salon

Electric bells, electric motors, loud speakers are all pieces of apparatus which employ electromagnets. The re-wiring or re-coiling of these magnets in electric motors is an expert job. All motors should be returned to the works if faults occur.

THE ELECTRIC MOTOR

It was mentioned earlier that the motor resembles the dynamo in construction.

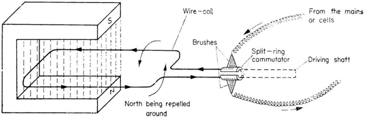


FIG. 113. *Principle of the electric motor.*

Electricity is passed through the coil of wire on the spindle and the coil becomes an electromagnet. This coil of wire is fixed between the poles of a permanent magnet. The coil magnet is pushed around as a result of the repulsion of like poles. After this single spin the poles of the coil magnet change over, due to split-ring commutators being used. This produces another spin due to the repulsion of like poles. This process is continuing at a very high speed all the time. This basically is how the electric motor works.

Applications in the Salon

The fan inside the hairdrier is driven around by an electric motor. Faults with this motor may be due to loose brushes or oil and dirt under the contact between brush and commutator. Motors may be a.c. or d.c. The type of motor used should always be checked before plugging into the mains. A universal motor may be used on either current.

THE HAIRDRIER

(a) *Installing the Drier*

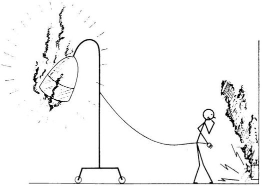


FIG. 114. *Installing the drier.*

When a hairdrier or a group of hairdriers is being installed into a salon the advice of an experienced electrician is important. The main cable from each drier should be connected to a three-pin plug of not less than 5 amps. The green wire of this cable should be connected to the earth pin (labelled E). The red wire to the right-hand pin (labelled L for live), the black wire to the left-hand pin (labelled N for neutral). These connections are

made with the centre pin, earth pin, uppermost. Some plugs and adaptors will have their own individual cartridge fuses; check that these are not already "blown".

It is important that the socket into which the plug is fitted, is efficiently earthed. This should be checked by a competent electrician.

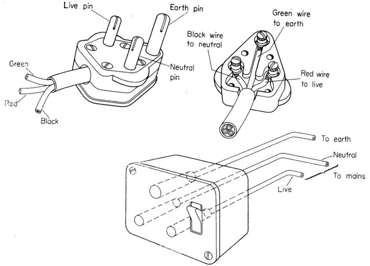


FIG. 115. *Wiring the plug.*

(b) *Operating the Drier*

The hairdrier simply contains an element that is heated by means of an electric current, and a fan that blows the warm air created by the element, over the hair.

There are many different makes of hairdrier and the details of each vary with the manufacturer, and price paid for the appliance. This brief account is not meant to replace the valuable information supplied by the manufacturer with each type of drier,

In general driers fall into two classes depending upon the mode of control of the temperature of the circulating air. (a) Temperature controlled by a "pendant" switch handled by the client. (b) Temperature controlled by means of an electrical thermostat fitted to the drier.

(a) *Client-controlled Drier*

This type of drier may be fitted with a pendant switch which is held by the client during the drying procedure. This switch may have four positions—"off, hot, medium and cold". This gives the client control over the performance of the drier.

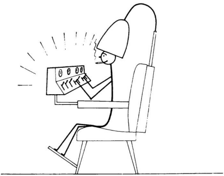


FIG. 116. *Client-controlled drier.*

If a "silent model" is being used, an amber light on the hood will indicate whether the drier is switched on. At the rear of the hood of these driers there may be two switches marked "summer—winter" and "fast—slow". As the weather changes so these switches are altered. The "fast—slow" switch controls the speed of the motor. Normally the "silent" drier operates on the slow speed, but it is advisable to start the motor with the switch on the

"Fast" position then switch to "Slow". This method gives a faster and more comfortable dry with much less motor noise.

For a rough dry, as after a pre-perm shampoo, the switch can be moved to "Fast". For cooling down purposes, the switch should be moved to "Cool".

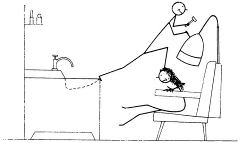


FIG. 117. *Maintaining the drier.*

Maintenance. Before any maintenance is carried out upon a drier, the electricity must be switched off and the plug withdrawn. Dust and dirt may be removed from the motor by means of a blower or vacuum cleaner. Most of the motors in these driers are a.c. (alternating current) and are self-lubricating. If the motor is d.c. (direct current) and fitted with brushes, then it must be examined fairly frequently to remove dirt from the brushes or to fit new brushes if they are worn down.

If the motors require oiling, care should be exercised in avoiding over oiling. This oil may be flung inside the hood as the motor speeds up.

(b) *Thermostatically Controlled Drier*

This type of drier may be pre-set to attain a certain temperature. A simple rotary switch control with points marked "cooler, average and hotter", operates a thermostat device which pre-

determines the temperature of the air circulating around the hair. This is automatic, thus no "summer–winter" switch is found on this drier. A motor speed control switch may also be present on the same apparatus with the "off–normal–high" positions; this is the main control.

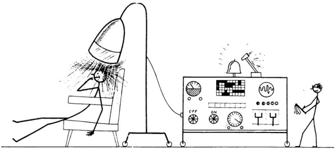


FIG. 118. *Automatic control of the drier.*

As the thermostat adjusts itself a soft click is heard inside the hood. Also, a thermostat light will be "on" when the air is getting hotter. If the voltage of the mains should drop then a mechanism will adjust accordingly and the cooling action will be delayed. If the voltage should increase then the thermostat will cope with this and the heat will be switched off at more frequent intervals.

Maintenance. These machines require little more than dusting. The thermostats and reversible switches should not be touched by the operator if they go wrong. The machine should be returned to the works. The a.c. motors are self-lubricating.

When using any type of hood drier it is a bad practice to place towels over the hood whether the motor is running or not. Dust, hair and towel fibres will soon congest the workings of the motor.

The Vibro Machine

This machine is a vibrator used for massage. It is best used only by an operator already skilled at manual massage.

The machine itself simply drives a shaft in an up and down movement. To the end of this shaft are attached rubber applicators of varying design.

This instrument is meant to stimulate muscle tone and blood circulation.

The High Frequency Machine

The high frequency machine is a piece of apparatus used in the salon to supply high voltage electricity of high frequency. The mains electricity is put into the machine and the current is reduced but the voltage increased. The frequency of the mains electricity is increased greatly. The voltage may be increased to as much as 2000 and 100,000 volts.

The frequency may increase from 50 times per second to 20,000 times per second.

These changes in the mains electricity are brought about by an *induction coil.*

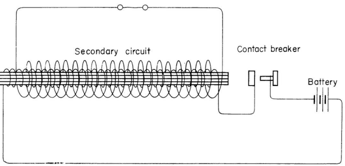


FIG. 119. *Induction coil.*

An induction coil is made up of two coils of wire one inside the other. The inner coil of wire is wound around soft iron rods. The outer coil separated from the inner coil consists of a great number of turns of very thin wire. The inner coil is called the *Primary coil*, the outer coil the *Secondary coil*. When the high frequency machine is switched on, mains electricity passes into the primary coil of the induction apparatus. As the electricity passes through this coil the iron rods become magnetic—an electromagnet. The lines of force around this magnet cut across the thin wires in the secondary coil. This produces an electrical impulse of *high voltage* in this coil (an *induced impulse*).

If the electricity is switched on and off in the primary coil then the induced current in the secondary coil will alternate back and forth many times per second. As the electricity is turned on the induced current flows in one direction, as it is switched off the current flows in the opposite direction. A spring make and break mechanism is fitted to the induction coil in order to produce these high frequency alternations. The frequency may be 15,000 to 20,000 times per second.

Using the High Frequency Apparatus

The high frequency apparatus may be employed with various glass electrodes which are moved in circular motions over the scalp or face. The client may hold one metal electrode tightly whilst the operator acts as the other electrode and massages the scalp with the finger tips. This treatment is stimulating to blood vessels in the scalp and a heat sensation stimulates the scalp nerves. This heat is produced by "eddy currents" in the skin, not the high frequency itself.

If metallic objects, jewellery, wrist watches, are in contact with the skin during the treatment, heat may be produced around these objects due to the same eddy currents. It is advisable to remove all metal objects during high frequency treatment. The speed with which the alternating current changes does not allow it time to produce those chemical changes in the skin which we

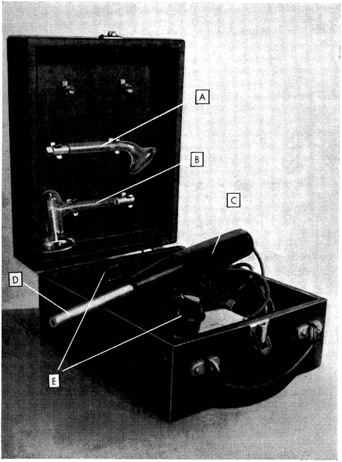


FIG. 120. *High-frequency apparatus.* (*a*) *Small surface electrode.* (*b*) *Larger metal filament, surface elecrode with greater heat effect.* (*c*) *Vulcanite holder.* (*d*) *Hand electrode in holder.* (*e*) *Controls.*

would normally experience as "shock". The electricity flows over the surface layer of the skin and does not penetrate deep enough to stimulate nerves into activity and perhaps damage other tissues. A certain amount of ozone is produced as a result of the sparking. This has antiseptic qualities.

The operator using this apparatus must check that the client is not hypersensitive in any way and liable to react badly to the treatment. The hair must not be wet, nor must the operator or client be in contact with liquids or metal objects. The electrodes must be sterilized. The "sparking" must be reduced to a minimum, even though it has certain antiseptic properties it does not improve the treatment and may frighten the client.

Observe the manufacturers' instructions.

The Steamer and its Functions in the Salon

The steamer consists of a transparent hood-shaped apparatus into which the client puts her head.

When the machine is switched on, distilled water from a reservoir on the machine is brought to boiling point by a heating element. This takes a little time. The steam produced is passed into the hood. The client's hair is then in close contact with the steam. The value and growing importance of this apparatus in the salon is due to the fact that the permeability of the hair to various solutions, such as perm solutions, tints and bleaches, is increased when the temperature of the hair is high. Thus operations taking place in the steamer take place more rapidly.

A bleach, a tint or a perm solution will enter the hair with greater ease when the hair is heated. The hair tends to swell temporarily and the outer scales of the hair open up, allowing better penetration.

The Thermal Cap

This is a plastic cap containing an electric heating element. The cap is normally used for the same purpose as the steamer in

order to condition the scalp with creams. When in use the cap is kept clean by covering the treated hair with a cloth before the cap is placed into position.

SOME PRECAUTIONS TO OBSERVE WHEN USING ELECTRICAL APPLIANCES

(1) Always switch off and remove the plug of apparatus when it is not in use or is to be repaired.

(2) Do not pull plugs out by the flex or use flex that is frayed at the plug junction.

(3) Broken tops on plugs or switches must never be allowed—a fatal shock may result.

(4) Electrical wires must be lead around the wall edge, not across floors over which people walk.

(5) Never touch electrical apparatus with wet hands or if in contact with water in any way.

(6) If they are used in the salon, always keep electric fires well away from trailing gowns or towels.

(7) Do not drape towels, etc., over the hoods of driers.

(8) Always have faulty apparatus checked by an electrician. Make sure all apparatus is well insulated and earthed.

(9) Do not run apparatus off electric light plugs as you may overload the circuit.

XIX
THE HEALTH OF THE HAIRDRESSER

THE work of a hairdresser is exacting. It is skilled work, and it is an intimate service for another person. The hairdresser must therefore be patient, courteous, interested and alert. At the same time the work can be physically tiring and she will not be able to do it well unless she is healthy and comfortable in mind and body. Fortunately there is much mental stimulus in designing and executing hairstyles for different customers, but her mind needs to nourish itself with other interests as well.

Her body must be fed, kept clean, clothed and given exercise and rest.

FOOD

The Body's Needs

The body needs food (1) in order to grow and to renew itself. For example hair, nails and skin grow all through life; tissues throughout the body wear out and are renewed; red blood cells are constantly being made; cuts and scratches heal. (2) to give warmth and energy by combining with the oxygen breathed in by the body. (3) to develop resistance to infection, for instance by making white corpuscles in the blood; by making chemical

changes in the body to fight disease organisms when they enter. (4) to regulate the activities of the organs, for instance the regular work of the sweat glands; the clotting of blood; the making of hormones; making the red colouring matter of the blood.

Nutrients

The substances in the food we eat which help the body to do these things are called *nutrients*, and a good diet is one which gives an adequate balance of these nutrients together with plenty of water. The chief nutrients are proteins, carbohydrates, fats, minerals and vitamins. Most food contains several of the different nutrients.

Proteins are the nutrients which build and repair the body. They are found in animal foods and some vegetables. The body needs a mixture of animal and vegetable proteins. The body cannot store proteins it does not use immediately.

Carbohydrates produce energy for the body's daily work and heat to warm the body. Carbohydrates almost all come from vegetables. The body can store carbohydrates in several forms if it is given more than it needs. Carbohydrates should be eaten together with fats and proteins.

Fats are also fuel foods and produce heat and energy. They are more concentrated than carbohydrates and are more easily used by the body if they are eaten with carbohydrates. Fats come from animal and vegetable foods, sometimes in the form of oils. They are digested more slowly than other foods and therefore fatty foods make satisfying meals. Extra fat can be stored by the body.

Minerals. Small amounts of elements known as minerals are needed by the body to carry on its essential work. The main minerals needed are calcium, phosphorus, iron, sodium, chlorine and iodine.

Vitamins are substances needed in very small amounts by the body but without which life could not be maintained. They are all chemically distinct from each other and each one has a particular part to play in the working of the body. A number of vitamins have been isolated but it is only necessary here to discuss

a few of them. They work together with the other nutrients to help in growth, repair and the production of warmth and energy. If the diet is lacking in any one vitamin the body cannot function efficiently and will break down in due course.

Water is essential to the body. It needs a constant intake of water and could not live for more than three or four days without it. Three-quarters of the body's weight is made up of water and every living cell of every tissue has water in it and is being constantly bathed in watery fluids. We could not digest any food without water because it makes up a large part of our digestive juices, or, having digested it we could not absorb it because the blood, which is the transport system of the body, is made mostly of water. The temperature of the body is partly regulated by means of sweat, which is almost all water. Water is used to wash out waste products from the body, through the kidneys.

We are losing water from our body all the time, in our breath, as sweat, as urine and in our faeces, so we must replace it steadily. Fortunately a quick reaction to lack of water is for us to feel thirsty and so we replace the lost water without thinking very much about it. There is water in most of the food we eat as well as in the beverages we drink, and the breaking down of food inside the body forms still more water, so that the loss and gain even up. The kidneys are sensitive organs and are able to regulate the amount of water lost in urine.

Diet

A good plan is to eat some of all the nutrients at each meal. This is easy because our ordinary meals contain most of them. The nutrients most often left out are the vitamins and these can be included by adding some fresh fruit or a salad to the more usual food. Fish, chips and peas contain animal and vegetable proteins, fat, carbohydrate and some of the minerals and if a fresh tomato or an orange were added the meal would be a balanced one. Bread and butter and cheese with a glass of milk and some watercress make a simple balanced meal. With a little thought it is possible to eat a good helping of protein and some foods containing

minerals and vitamins at each meal and to complete the menu with the usual energy foods such as potato, steamed pudding or ice cream. Many hairdressers will take a packed lunch to work and in this case the sandwich fillings can provide the protein (cheese, meat, sardines, egg) and lettuce or fruit will provide the vitamins. The minerals are usually found in food together with the other nutrients.

Fruit and vegetables are useful for another reason: they provide what is known as roughage. This is made of the stringy and tough parts such as the skin of fruit and the fibres of green vegetables. The human body cannot completely digest them and so they form a bulky part of each meal and stimulate the intestines to make strong muscular movements so that they pass out waste regularly.

Of course it is important that the value of food should not be spoilt by bad cooking. It is better to undercook than overcook vegetables. Green vegetables should always be dropped into water already boiling and cooked quickly. Uncooked fruit and salads are extremely valuable but their value diminishes with time so they should be eaten as freshly picked as possible. The following table will help the hairdresser to choose her diet sensibly.

Nutrient	Use in Body	Common Sources
Animal protein	Growth and repair	Meat; fish; cheese; eggs; milk.
Vegetable protein	Growth and repair	Beans; peas; lentils; peanuts; whole meal flour.
Carbohydrates	Provide energy and warmth	All starch and sugar foods e.g. bread; biscuits; cake; cereals; potato; jam; syrup; sweets.
Fats	Provide warmth and energy in more concentrated form	Butter; margarine; dripping; fat of meat; oily fish, e.g. sardines and herrings; cheese; eggs; olive oil; other salad oils; nuts.

Nutrient	Use in Body	Common Sources
Minerals:		
1. Calcium	Helps growth. Provides building material for bones and teeth. Helps blood to clot and muscles to work.	Milk; cheese; sardines; watercress; haricot beans; nuts; eggs.
2 Phosphorus	Works with calcium to form bones and teeth. Forms part of nerve and brain cells	Cheese; oatmeal; kidney; eggs; milk. Most foods contain a little.
3. Iron	Makes the vital red colouring matter of the blood	Liver; kidney; lean meat; eggs; dried fruit, e.g. raisins; cocoa; cabbage; watercress; peas.
4. Iodine	Keeps thyroid gland healthy	Sea fish; drinking water in most areas.
5. Sodium 6. Chlorine	Together as sodium chloride (common salt) form an essential part of all body fluids. Chlorine helps to form gastric juices for digestion	Table and cooking salt; kipper; bacon; bread; butter.
Vitamins:		
1. Vitamin A	Helps growth. Prevents colds, influenza, bronchitis; helps eyes to see better	Liver; milk; butter; cheese; margarine (added by law); egg yolk; oily fish; tomato; carrot; lettuce; spinach.
2. Vitamin E	There is a group of vitamins known as the Vitamin B group but there is no need here to separate them. Between them they help growth; prevent constipation; keep nervous system healthy; help to keep skin healthy; help body to make the best use of carbohydrates, fats and proteins	Meat; liver; kidney; wholemeal bread; Marmite; peanuts; peas; beans.

Nutrient	Use in Body	Common Sources
3. Vitamin C	Helps growth. Helps wounds to heal well Helps body to resist infection and is essential to good health.	Most fresh vegetables and fruits, especially lettuce; brussels sprouts; cabbage; watercress; oranges; grapefruit; blackcurrants; gooseberries; strawberries.
4. Vitamin D	Helps growth. Works with calcium and phosphorus to build strong bones and teeth.	Oily fish, e.g. sardines and herrings; margarine (added by law); butter; milk; eggs.

CLEANLINESS AND COMFORT

The Body

Nobody has to be told in these days how important a daily bath or all-over wash is. A bath, wash or shower, with soap and a body brush or rough towel, removes dead skin, dirt, minute disease organisms, body grease (sebum) and dried salts left by evaporated sweat.

The apocrine glands in the armpits produce sweat which has a strong smell. In some people this smell is stronger than in others. Hairdressers in particular do not wish to offend customers with the smell of stale perspiration, but they work in a warm, humid atmosphere and may perspire freely. They are particularly careful about bathing.

For the same reason they use clean underclothes daily. Modern fabrics are easy to wash and dry and this daily change of clothes is no problem.

The Hands

The hairdresser's hands are the point of contact between her and her customers. For that reason they should look attractive and be scrupulously clean. But just because they are her chief

tools, these ideals are difficult to achieve. The hairdresser's hands are in contact with water and detergents a great deal. This tends to dry the skin which may then roughen and crack. Cracks in skin can be unsightly and painful and they allow the entrance of disease organisms which may cause areas of infection, and infection of this kind can be passed on to the customer. Barrier creams applied before using water and detergents often help to prevent dryness of skin and a good skin cream rubbed well into the hands at night is also useful .

Then the hairdresser's hands are frequently in touch with strong permanent waving, bleaching and dyeing fluids. Rubber gloves should be used for work of this kind wherever possible.

It should not be necessary to point out that the hairdresser's hands should be thoroughly washed and a nailbrush used after any cleaning work in the salon (dusting, polishing mirrors, sweeping up hair) and after every use of the lavatory. Hands can carry infection even if they seem to be clean.

Customers take particular notice of the hairdresser's nails. These should not be worn long because this can be dangerous to the customer's skin and it is difficult to keep long nails really clean. Long, broken nails are unsightly, so they should be trimmed to a curve which suits the shape of the fingertip. If the hairdresser uses coloured nail varnish it should be in a pale shade. The cuticles of nails should be kept soft and pliable and this can be done by massaging almond oil or a good cream into them every night.

If a finger is cut or badly scratched the place should be covered, but surgical tape is unsightly and collects dirt on the outside. It may be possible to use collodion.

A few people react violently to one or another of the detergents and chemicals used in the craft and they develop patches of inflammation on the skin of the hands. Unsightly and painful rashes can appear. These are not infectious but medical advice should be taken about them, because no customer cares to be touched by hands with a rash, and in any case they may cause intense irritation and suffering to the hairdresser. Rubber or plastic gloves can probably be worn for operations where the

particular chemical is involved, or the doctor may suggest other means of overcoming the difficulty.

The Feet

A hairdresser spends most of her working day standing, and this means that she must take care of her feet. Tired and aching feet are exhausting and lead to bad standing habits and a look of weariness and strain. The foundation of comfort is a well-fitting pair of shoes. Height of heels does not matter so long as the feet are perfectly comfortable. What is more important is that there should be plenty of room for toes to move easily inside the shoe, that the heels should fit snugly, that the arch of the foot be supported and that the sole be wide enough to give a good walking base. Shoes should be of as good a quality as the wearer can afford, and it is wise to buy them in the afternoon when the feet are a little swollen.

The feet will, of course, be washed thoroughly every day, scrubbed with a brush, dried carefully and dusted with talcum powder. Stockings should be washed after every wearing. It is a good idea for the hairdresser to have a second pair of stockings at work. Halfway through the day she should change her stockings, at the same time giving her feet a good rubbing with methylated spirits or a toilet cologne. Shoes will remain comfortable and last longer if they are worn on alternate days, so that to have two pairs of working shoes is a good investment. This gives each pair time to dry out and resume their correct shape. Feet perspire a good deal and shoes are slightly damp inside after hours of wearing. If they are stuffed with tissue paper immediately they are taken off they will dry in shape.

Stockings should fit as well as shoes. Stockings too large cause uncomfortable lumps and folds inside the shoes, and stockings too small cramp the toes.

It is often said that toenails should be cut straight across, and this is certainly better than cutting them down at the sides into a point at the middle, but it is better still to shape them to a very

gentle curve. This avoids painful pressure by the nail on the surrounding skin.

Feet sometimes develop painful or irritating conditions, and these should be dealt with immediately. Corns should not occur if shoes fit properly, but if they do it is best to go to a chiropodist. Thick pads of skin may form on the inner side of the sole and round the heel and these can be treated by soaking in a solution of bicarbonate of soda and warm water and then rubbing with a nailbrush or pumice stone. A continual burning sensation on the ball of the foot may be caused by a virus infection and should be dealt with by a doctor or chiropodist. An irritating condition which sometimes develops between the toes is known as athlete's foot. The skin is inflamed and shows blisters and patches of moist white tissue. This is another infection, caused this time by a fungus, and it may be spread anywhere where people walk about with bare feet, so the hairdresser may pick it up in the staff changing or wash rooms at her place of work. The condition needs medical attention and the sufferer should not walk about barefoot where she might pass on the infection to others. The doctor will tell her how to treat her stockings so that she will not reinfect herself.

Tired feet may need exercises to help to strengthen the muscles which support the arch Picking up a pencil with the bare toes, walking barefoot on tiptoe and then on the outer sides of the feet and then on the heels, turning the feet in a circular movement on the ankles will all help, but if the arches are badly fallen expert medical help is needed.

The Mouth and Throat

The hairdresser's mouth and throat can be a source of nuisance and risk to the customer as well as a danger to her own health if hygiene of this part of the body be neglected. Nobody enjoys being in intimate contact with somebody whose breath smells unpleasant and a customer will avoid a hairdresser who offends in this way. Badly cleaned teeth smell unpleasant because pieces

of food are fermenting and decomposing around and between them, and decaying teeth may be even more unpleasant. An unhealthy throat, septic tonsils or constant catarrh mean that the mouth and throat are breeding places for disease organisms which the hairdresser is constantly breathing out over the customer.

Teeth should be cleaned regularly at least night and morning, with a brush kept for each time of day and a favourite toothpaste or powder. If two brushes are used each has time to dry out properly. Brushes should be replaced frequently because a soggy, unclean toothbrush may harbour bacteria and do more harm than good. An apple eaten after a sandwich lunch helps to clean the teeth. Decayed teeth do not chew food thoroughly and as well as toothache and unpleasant breath digestive upsets can follow, but regular visits to the dentist will keep the teeth in good order.

Constant sore throat, colds and running nose should warn the hairdresser that her throat is not healthy and she should ask her doctor's advice. Even if she has a perfectly healthy throat she will find that a good mouthwash will help her to feel secure that she is not offending customers.

Hair and Skin

There is no need to tell a hairdresser about the importance of clean, well-groomed hair, nor about the necessity to keep her skin fresh and clear. No responsible hairdresser will use too much makeup nor fail to clean makeup off carefully before going to bed. She will use a good cream and then a mild soap and water. She will also clean her face and completely renew her makeup at least once during the day. In some people over-active sebaceous glands may block hair follicles on the face with sebum, and cosmetics and dirt will then collect on the oily surface of the skin, giving a grimy look. If this condition occurs makeup should be removed and the skin thoroughly cleaned several times during the day. Calamine lotion should be used on any inflamed spots.

The basis of a clear skin is a good diet, plenty of fresh air, exercise and enough sleep.

CLOTHES

Although we wear clothes for several reasons—custom, adornment, protection against surface injuries, temperature regulation—it is the last, temperature regulation, which is the most important for health and comfort. In cold weather we want our clothes to keep us warm, and when it is hot we want them to keep us cool. They do these things in two ways.

1. Our clothes receive heat from two directions at once—from our surroundings on the outside and from our bodies on the inside. They conduct heat from whichever side is the hotter to the side which is cooler. If we sit in front of a hot fire our clothes absorb heat radiating from the fire and conduct it inwards to our bodies. If we sit in a cold room our clothes absorb heat from our bodies and conduct it out to our surroundings. It matters a good deal to us, then, whether our clothes are made of materials (a) which are good conductors of heat and (b) which can or cannot hold air in their meshes, because air itself is a bad conductor of heat, although when it moves about it can carry heat easily from one place to another.

A material which can enmesh air and keep it from moving can slow down the convection and conduction of heat and if, like wool, it is also itself a bad conductor of heat then it makes a warm garment. When our bodies want to get rid of heat the small blood vessels under the skin dilate and allow blood to pour through them. The heat radiates from our bodies and we then want clothes made of material which does not enmesh air and which is itself a good conductor of heat, so that the heat is carried away quickly. This is a cool garment.

2. There is another factor involved in the temperature regulation of our bodies and this is the evaporation of sweat. You remember that, whenever water evaporates there is a drop in temperature, and also that warmth and moving air speed up evaporation. When we are hot we sweat freely and we want clothes of material that will allow air to move easily through it so that our sweat can evaporate. If the material will also absorb the

sweat and then allow it to evaporate it is even more comfortable. When we are cold we do not sweat so freely but sweat is coming from our skin all the time in small quantities. We then want clothes that will slow up the movement of air so that evaporation will not take place so quickly that we will notice a drop in temperature. We must have some movement of air around our bodies or we should lose no heat at all and we should soon begin to feel uncomfortable and ill.

Hairdressers work in an atmosphere which is warm all the year round and it is only when they leave the salon in winter that they need warm clothes. Most of the time they need clothes which will allow their bodies to lose heat and which will absorb perspiration. Let us make a list of what a hairdresser requires of the clothes she wears in the salon.

1. They should allow air to circulate round the body so that sweat can evaporate.
2. The underclothes should also absorb sweat.
3. They should be good conductors of heat.
4. They should launder easily, because the hairdresser needs clean clothes every day.
5. They should allow free movement of the body and not be tight anywhere.
6. They should be light in weight.
7. Her overall should

   (a) be attractive, neat and of a material which will keep its shape despite being laundered frequently and will not crease;

   (b) be hard wearing;

   (c) be pale in colour to reflect and not absorb heat;

   (d) protect her clothes. This means that it should be strong, should not absorb water easily and should not pick up dirt easily. If it can also stand up to mild acids and alkalis so much the better.

   When she is using hair dyes she should have a special overall or apron of a non-absorbent material and in a dark colour so that spilt dye will not penetrate to clothes beneath and will not show up in an unsightly way on the overall.

8. Shoes and stockings should be comfortable and the shoes should support the feet.

On the whole, this means that underclothes are best made of fine cotton which absorbs moisture well and allows air to circulate freely, and is a good conductor of heat. Overalls, on the other hand, are best made of (a) cotton or linen with modern drip-dry, water-repellent, crease-resisting finishes or (b) rayon or nylon. Nylon is stronger, more hard wearing and keeps its shape better than rayon. It also launders more easily because it dries quickly and does not need ironing. On the other hand, it attracts dirt, especially on collars and cuffs, tends to discolour and is more expensive than rayon. It is also hotter because air does not move through it easily unless it is of too loose a weave for an overall.

Fabrics are made of knitted or woven yarn and yarn is spun from fibres. Some fibres occur naturally in parts of plants or animals, and examples of these are cotton, flax (linen), silk and wool. Others are made in laboratories and factories by the chemical treatment of materials such as wood pulp and the by-products of petroleum and coal. These are called man-made fibres.

In these days, however, a very great variety of fabrics is produced by mixtures and blends of natural and man-made fibres. A mixture is a fabric made of two or more yarns put together during the weaving, e.g. nylon yard going one way (warp) and cotton yarn going the other way (weft). A blend is made by spinning the yarn itself from two different fibres, e.g. a man-made fibre and wool. These mixtures and blends make it possible to combine the qualities of the different fibres. It makes choice of materials for clothes at the same time more complicated and more interesting, and it makes necessary careful washing instructions with each garment or length of material. A great many different "finishes" are now given to fabrics and we have come to expect dress and overall materials to be creaseless, mothproof, permanently pleated, drip-dry, stain repellent, and non-iron.

The following table gives a few of the properties of fabrics used for clothing.

Fabric	*Absorbent Quality*	*Ventilating Quality*	*Laundry*	*Special Qualities*	*Suggested Use*
Natural					
Cotton	Good	Good	Easy to wash and iron	Conducts heat well. Wears well. May have drip-dry and crease resistant finish	Underclothes, especially in summer or a heated salon. Overalls
Linen	Very good	Good	Washes well but takes time to iron	Good conductor of heat. Hard wearing. May have crease resisting finish; otherwise creases easily. Expensive	Only finest quality suitable for underclothes and this is expensive. Overalls look tailored and smart if crease resistant
Silk	Poor	Fairly good	Needs care	Hard wearing. Very expensive. Good conductor of heat	Too expensive for daily use
Wool	Good	Allows slow circulation of air	Needs great care—shrinking easily	Holds air between fibres and therefore feels warm. Is strong, elastic and light. Bad conductor of heat. Naturally attacked by moths but may be made moth-proof	Outer garments in winter

Fabric	*Absorbent Quality*	*Ventilating Quality*	*Laundry*	*Special Qualities*	*Suggested Use*
Man-made Fibre Rayon	Good	Depends on weave—knitted is good	Easy to wash, dry and iron but weakens when wet and should not be wrung hard. Needs frequent wash	Not very hard wearing. Reasonable in price. Good conductor of heat. Moth-proof	Underclothes in knitted fabric. Overalls in woven fabric
Tricel	Fair	Depends on weave—knitted is good	Easily laundered. Drip dry. Resists soiling	Will not shrink, stretch or crease. Wears well. Moth-proof	Underwear. Blouses
Nylon	Poor	Depends on weave. Close weave very poor; open weave good	Very easily dried. Tends to attract dirt which is hard to remove. No ironing needed	Very strong and hard wearing. Elastic. Moth-proof	Stockings. Overalls

Fabric	*Absorbent Quality*	*Ventilating Quality*	*Laundry*	*Special Qualities*	*Suggested Use*
Terylene	Poor	Depends on weave—open weave good	Washes and dries easily. Little ironing needed	Strong and hard wearing. Has a warm feel. Moth-proof	Lightweight weaves for underclothes. Heavier for skirts and suits
Acrilan and Courtelle	Poor	Good in jersey weave	Easily laundered. Needs little ironing	Strong, hard wearing, light and warm. Keeps shape. Moth-proof	Dresses and outer wear especially in winter

RELAXATION AND REST

However interesting her work is the hairdresser, like everybody else, needs a change of occupation, some rest during the day and some hours of sound sleep at night.

Fortunately the hairdresser's work is fairly varied, but she does it standing, and in a warm, humid atmosphere. On exceptionally busy days she may suffer mildly from muscle fatigue, heat fatigue and mental fatigue.

Muscle Fatigue shows itself by a slowing-down of work, clumsiness and loss of dexterity and by some aching in the muscles most used—legs, feet, arms, back, hands and fingers in this case.

Heat Fatigue is accompanied by slight dizziness, headache, extra perspiration, thirst and irritability.

Mental Fatigue often takes the form of a feeling of tightness round the head and inefficiency in work—making mistakes, dropping things, forgetfulness.

These forms of fatigue can be avoided by (a) learning to stand and move properly (expert advice can be taken about this), (b) resting with the feet up on a chair or even lying on the floor with legs and feet higher than the head for a few minutes several times during the day, (c) going for a short, brisk walk, even if only round the block, during the lunch break, (d) seeing that the salon is ventilated as well as possible, (e) drinking plenty of fluid.

Recreation after working hours should include some form of exercise, preferably in the open air. If the hairdresser takes her exercise in the form of dancing she should make sure of getting plenty of fresh air as well, perhaps by walking part of the way to work each day.

Exercise uses other muscles as well as the ones used in work, and uses those in different ways. We breathe more deeply as we exercise and this helps the blood to circulate more quickly. This in turn helps us to digest our food better and to get rid of waste. More waste matter is carried to the kidneys to excrete as urine and the bowels are stimulated to pass on unused food materials so that we avoid constipation.

The hairdresser should try to spend some time in sunlight whenever that is possible because sunlight has some good effects on the skin—it stimulates some of the chemical activities of the blood, kills bacteria and forms Vitamin D in the skin. Too much strong sunlight at one time can be dangerous, however, because it can cause real burning of the skin with accompanying headache, sickness and possible rise in temperature.

The hairdresser should see that her mind is stimulated as well as her body by taking part in games, talking with interesting people, learning something new or seeing plays, reading or listening intelligently to music.

She should average about eight hours sleep at night in a comfortable bed with light, warm bedclothes and in a well-ventilated room.

XX
INFECTION AND INFESTATION

INFECTIOUS DISEASES

WE said in Chapter 1 that a dirty hairdressing salon could be a danger to the community. It can be a danger because it can be a focus for spreading infectious diseases.

An infectious disease is one which can be passed on from the sufferer to another person. It is caused by a living organism, and organisms which cause disease are known as pathogens. This word means "giving rise to suffering".

There are four groups of living organisms which can cause infectious diseases in man: plants, animals, bacteria and viruses.

PLANTS WHICH CAUSE DISEASE

The plants that cause disease in man belong to the large group of plants known as fungi. These plants have no green colouring matter and therefore cannot make their food from raw materials in air and soil. They must take their food from other plants or from animals. Some of them live on dead and decaying plants and animals.

We are all familiar with moulds which appear on food such as bread left in our larders for some time in damp summer weather. Some look whitish-grey, some blue, some black. They are made of a mass of very fine, living threads which are much branched and

which run under and through the surface of the bread. This mass of cells is called a mycelium. The threads make and exude digestive substances which break down the bread into soluble material which the threads then absorb. This is their nourishment.

Fungi which cause disease in man form a mass of similar threads in his skin which they break down in order to absorb nourishment from it. They grow in the epidermis and rarely reach down to the dermis.

Fungi on bread, cheese and other foodstuffs look green, grey or black because they grow branches which produce masses of spores and it is the spore-cases which are coloured. When they ripen the cases burst and the spores are scattered. Each spore which falls on suitable material germinates and grows a new mycelium. Many fungi growing in the skin of man do not produce spores. They spread simply by the growth of the mycelium.

Some Diseases Caused by Fungi

1. *Scalp ringworm.* This occurs most often in children, usually under the age of twelve years. The mycelium of the fungus grows in the upper layers of the epidermis of the scalp. It spreads into the hair follicles and grows round the hairs and even into the shafts of the hairs themselves. This weakens the hairs and they break off. A person with ringworm of the scalp will have a round patch of greyish, scaly skin on her scalp. No long hairs grow in this patch but short, stubby lengths of hair shaft can be seen where infected hairs have broken off close to the skin. In some cases there is some redness and soreness in the patch of skin.

Epidemics of scalp ringworm arise among school children. The disease is spread by direct contact of the children's heads and by the wearing of each others' hats. The hairs which break off and which are filled with the threads of the fungus can carry the infection. They fall onto clothing, furniture or the floor and are blown about in the dust.

It is unlikely that a child suffering from ringworm of the scalp will be brought to a hairdresser but if the disease is only just

appearing on the child's scalp it is possible that the hairdresser may be the first to notice it.

The hairdresser is not concerned with the treatment of ringworm but it is of interest for her to know that because the fungus invades the hairs themselves where it cannot be reached by fungicides, the disease usually cannot be destroyed unless all the hair is first removed from the patient's scalp. This is often done by X-ray therapy. After all the hair has fallen out the scalp can be treated with disinfectants which kill the fungus in the skin before the hair grows again.

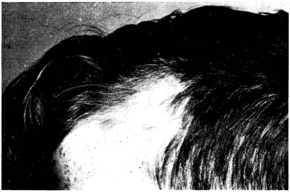


FIG. 121. *Ringworm.*

2. *Ringworm of the body* is caused by another fungus. It invades the skin of the body causing first a patch of inflamed and blistered skin. The centre of the patch soon heals and this leaves a ring of blisters. These blisters turn to pustules and then to scabs.

The disease may spread over the patient's body so that there may be many patches and rings of pustules. It is mostly seen in children but adults may catch the infection and the hairdresser may see it on the neck or arms of a customer.

3. *Ringworm of the beard* resembles ringworm of the body but it appears in the beard region of the face. In country areas it may be caught from cows which sometimes carry a species of fungus which gives off a strong toxin, and in this case the human sufferer will develop a form of beard ringworm which looks like clusters of boils.

4. *Ringworm of feet and hands*. Fungi can infect the skin of the feet and hands and ringworm of the feet is fairly common in this country. It is usually spread by the use of public swimming baths, showers, beaches, dressing rooms and other places where numbers of people walk about with bare feet. It is sometimes called "athlete's foot". It appears as a sodden patch, between the 4th and 5th toes, which is sore and irritable. It may spread to the other toes and over the ball of the foot, developing blisters and inflammation. It later dries up, forming scales and after a resting period it breaks out again. It tends to break out over and over again and it may give rise to a blistered eruption of the hands as well as of the feet.

Another ringworm fungus affects the palms of the hands and appears as areas of inflammation and groups of blisters and pustules. It is passed on from one person to another by the handling of objects. Another fungus affects the nails, causing them to crumble and become distorted.

5. *Honeycomb ringworm*. This form of ringworm is rare but cases occasionally occur. It can affect the skin of the body or of the scalp. In a case where the scalp is affected, patches of hair look lifeless and stiff and yellow crusts develop on the scalp. After some time areas of baldness appear and hair does not grow again in these areas. Toxins from the fungus damage the skin and the hair follicles are destroyed. As in ringworm of the scalp the threads of the fungus invade the cortex and medulla of the individual hairs.

ANIMALS WHICH CAUSE DISEASE

The animals which can cause disease in man are so many and so varied that they cannot be discussed here. Many of them are microscopic (e.g. the malaria organism), but others are large enough to be seen with the naked eye (e.g. roundworms). Disease-causing animals may be swallowed or they may enter through the skin. There are not a great many disease-causing animals in this country but there are a great many more in tropical countries.

Some animals live outside the body but feed on it and these can cause discomfort amounting to disease. Some of these will interest hairdressers.

Some Animals Infesting the Body

1. *Head Lice* are insects which live on the scalp, among the hairs of the head, and feed by piercing the skin with their mouth-parts and sucking blood. The females lay eggs, called nits, on individual hairs. The eggs are laid in a gummy substance which quickly hardens in the air and cements each egg to the hair. After about a week the eggs hatch and the young lice which emerge take another week to reach adulthood. They can then produce eggs.

Each female louse lives for about four or five weeks and may lay over 300 eggs in that time. Frequent washing of the head and hair discourage infestation by lice; a layer of dirt and grease on the scalp provides protection for them.

The irritation caused by the lice walking over the scalp and piercing the skin encourages the patient to scratch. If the skin is broken by the scratching, germs may enter causing inflammation and the appearance of pustules or an outbreak of impetigo which will cover the scalp with pustules and sore crusts.

Two steps must be taken to rid the head of lice—the adult lice must be killed and the nits removed. There are several prepara-

tions on the market which may be applied to the hair and scalp which will kill lice and nits but then the dead nits may have to be removed with a fine toothed comb. Each strand of hair must first be made wet by dipping the comb in a solution of vinegar and

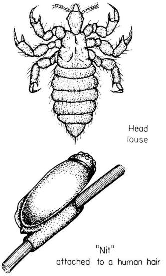


FIG. 122. *Head louse and egg.*

water in order to soften the cement which holds the eggs to the hairs. Directions on the packet of whichever preparation is chosen should be followed exactly.

2. *Body lice* are similar to head lice but they live in the seams of the clothes of their host and walk on to his body when they need to suck his blood. This leads to intense irritation and hence to scratching. Eggs are attached to clothing as a rule, although they are sometimes found on the fine body hairs. The hairdresser is not likely to see the body lice themselves but she may see signs of deep scratching on the neck and upper back of her client. The scratches may become infected so that impetigo or festering may be seen,

3. *The common flea.* This is another insect which lives by sucking the blood of its host. It is more commonly found than the body louse because it breeds in dust and rubbish and can move about very rapidly. It is therefore less easily destroyed than the louse which breeds on the body. The flea moves from person to person more freely than the head louse or the body louse because it can jump long distances, and it does not spend all its life on the human body.

Flea bites often occur in groups on the skin and each one looks like a tiny red spot surrounded by a pink patch which fades after a few hours. The spots are itchy and lead to scratching.

4. *The itch mite.* This small, eight-legged animal causes a disease called scabies. The animals live on the body and the females burrow under the surface of the skin making tunnels in which they lay their eggs. When the eggs hatch the young mites leave the burrows and lie in hair follicles while they grow and undergo changes in form. When they become adult they make new burrows. The burrowing causes intense itching which is made worse by the action on the skin of irritating secretions given out by the animal. The itching is always worst when the sufferer is warm so that the most irritable time is usually at night in bed. Small lumps and blisters may appear. Sometimes the lines of the burrows may be seen as fine lines beneath the surface of the skin. Scratching leads to breaks in the skin and secondary infection so that impetigo may be present and boils may occur.

The parts of the body most usually affected are between the fingers, the fronts of the wrists, the elbows, the sides of the chest and the abdomen. Scabies is infectious because the mites can creep directly from one person to another. Medical advice is necessary for treatment.

BACTERIA AND VIRUSES

Characteristics of Bacteria and Viruses

Bacteria and viruses are often together called "germs". This is a useful term because neither bacteria nor viruses can be seen

with the naked eye, they are passed from person to person in much the same way as each other, and both can cause disease. But although they are both microscopic they are quite different from each other.

1. Most bacteria can be seen under a microscope. They appear to be tiny specks of protoplasm which take characteristic shapes, usually round, rod-shaped or spiral, and a bacteriologist can identify them. Not by any means all bacteria cause harm to man. There are a great many different kinds of bacteria and most of them do not have any effect on man or his life. Some others can be used by man in the manufacture of such things as leather and cheese while others are vitally useful in breaking up dead organic matter. We know bacteria are alive because they need oxygen and nourishment like all living things and they can reproduce themselves. This they do very simply by splitting in half, and they do this very rapidly. Some bacteria form tough, thick-coated spores which can withstand dry conditions and great heat.

2. Viruses are very much smaller than bacteria and cannot be seen with an ordinary microscope. A great deal about the form and life of viruses is still unknown but virologists have been able to study the effects they have on plants and animals which they invade and are gradually learning more about the viruses themselves.

3. Harmful bacteria can multiply under suitable conditions on the surface of the human body, in between the cells of tissue, in the blood or in suitable material outside the body altogether, e.g. in milk or meat juices.

4. Viruses multiply only inside a living cell.

5. Bacteria, as well as invading body tissues, give off poisons (toxins) which can harm the tissues.

6. So far as we know, viruses do not do this.

Conditions necessary for the growth of germs are:

warmth
moisture
oxygen
nourishment
darkness

Conditions which stop or slow up the multiplication of germs are:

cold
dryness
lack of nourishment
light

Conditions which kill germs are:

heat
strong sunlight
fresh air (because it is cold and moving)
chemical germicides

BUT:

(a) some germs can withstand dryness for a long time;

(b) some germs develop spores which can resist great heat and dryness;

(c) germs inside specks of dried milk, pus or faeces are protected from high temperatures and so are often not killed by boiling of clothes or washing of dishes in hot water.

When it is suspected that these germs are present then more stringent measures must be taken against them.

Germs and the Human Body

Germs enter the human body (1) through the nose and throat, and affect the breathing organs. Examples are germs causing the common cold, influenza, tonsillitis, measles. (2) through the mouth and then affect the digestive tract. Examples are germs causing dysentery, food poisoning, poliomyelitis, typhoid fever. (3) through a break in the skin. Examples are germs causing boils, impetigo, tetanus. Each kind of germ settles in the part of the body which suits it best.

The weapons of germs are (1) the power of multiplying in the tissues and cells of the body and destroying them by breaking them up. (2) giving out poisons (toxins) which damage the body.

Some germs use only one of these weapons, others use both.

If germs reach the bloodstream they are carried by it round the body and they then have the opportunity of settling in a number of places in the body.

The weapons of the body to resist the attack of germs are:

1. phagocytes (white corpuscles which eat germs. See p. 27)
2. chemical changes resulting in the production of antibodies and antitoxins in the blood;
3. the rate of the blood-flow being increased and the body temperature rising. This helps the chemical changes.

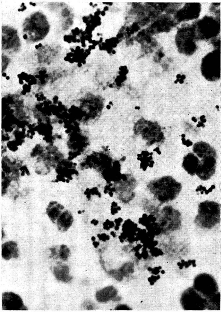


FIG. 123. *Bacteria (photomicrograph): Staphylococcal pus* x 2250

Some Diseases Caused by Bacteria

The bacterial diseases of interest to the hairdresser are mainly those which affect the skin. The organisms chiefly concerned

are two of the round bacteria, *staphylococcus* and *streptococcus*.

1. *Impetigo*. This is a highly contagious skin condition which may be caused by a staphylococcus or a streptococcus. The bacteria enter a break in the skin and settle in the epidermis. The eruption begins with the appearance of blisters filled with a clear liquid. The liquid soon becomes thick and yellow and a crust

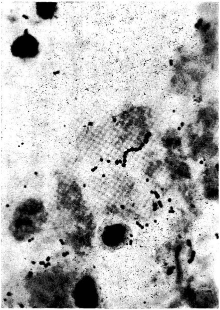


FIG. 123A. *Bacteria (photomicrograph); Streptococcal pus* x 2250

orms. It spreads rapidly and spots in all stages of development may be seen in the same area.

Impetigo may occur anywhere on the body but the commonest areas are the scalp and the face. It often follows scratching caused by the presence of head lice, body lice or the itch mite because the bacteria are commonly carried on the fingers and under the

nails. Children suffer from impetigo more often than adults except those adults who are normally unclean.

After treatment impetigo rarely leaves scars because only the epidermis is involved and not the deep layers of the skin.

2. *Boils.* A boil is usually caused by the infection of a hair follicle but sometimes the bacteria enter a sweat gland. The organism is a *staphylococcus* which is deposited on the skin by fingers, or dust, or droplets from nose or throat, and is then pushed into the follicle by scratching or rubbing.

Conditions in a hair follicle are favourable for the bacterium which then begins to reproduce. The body reacts by attacking the multiplying bacteria with white corpuscles and by increasing the flow of blood to the dermis round the follicle. The result is that a hot, inflamed lump is felt and this is tender and painful because the nerve endings in the surrounding skin are compressed. Pus develops in the follicle as a result of the fight between the white corpuscles and the bacteria and it is presently pushed outwards from the follicle to the surface of the skin, forming the "head" of the boil. After some time the boil bursts, releasing pus and blood which are full of live and dead bacteria. Dressings used to clean up after a boil has burst should be burned and the hands washed at once. A small scar is usually left because the dermis has been damaged and the dermis does not renew itself in the same way as the epidermis does.

3. *Acne* is a skin eruption usually seen in adolescents. It takes the form of "blackheads", many of which are surrounded by pustules.

Acne does not begin as a bacterial infection but as a greatly increased activity of the sebaceous glands in the hair follicles of the face. This excessive activity of the glands seems to be characteristic of adolescence.

The sebaceous gland gives off more sebum than can escape through the mouth of the follicle and the sebum becomes compressed into a waxy plug. Hard, dead epidermis cells near the mouth of the follicle become attached to this core of sebum and make the black top which is characteristic of the blackhead.

At this stage the *staphylococci*, which have been present in the follicle without doing any harm, become active and pus is formed

so that the blackhead becomes the centre of the pustule. The infection may spread deeply into the sebaceous gland and a large pustule may develop.

A great many sebaceous glands may be involved at the same time so that the young person may have a thick scattering of inflamed and pus-filled pimples over the face.

The original plug of sebum making the blackhead is not infectious but the pus which later develops will be filled with bacteria and if some of the pus is transferred to a cut or scratch on another person then infection may develop there and take the form of a boil or a local inflammation.

4. *Sore throats* are not skin conditions but they should be mentioned among bacterial diseases to be met in a hairdressing salon.

We carry normally in our noses and throats numbers of bacteria which do not harm us so long as we are in good health and can keep them under control. When we are overtired or not well, our bodies do not resist fresh invasions of these pathogens as strongly as usual. We then tend to develop sore throats, catarrh and running noses.

The hairdresser who shows these symptoms may take little notice of them but she is breathing germs over her customers and almost certainly has germs from her nose and throat on her fingers since she will cough into her hand, touch her mouth and nose, and hold her damp handkerchief. The germs from her sore throat are likely to be *streptococci* and *staphylococci* and they may cause the same sort of sore throat in the customer who breathes them in, or, if by chance they are rubbed into a small break in her skin or into a hair follicle, they may cause a boil or other skin eruption to develop.

Some Diseases Caused by Viruses

1. *The common cold* usually begins with a sore feeling at the back of the nose and by sneezing. This is followed by a day or two of watery discharge from the nose and possibly a slight rise in temperature, and a sore throat. The discharge then thickens to a yellow mucus for some days before the cold disappears. During

this last period some blocking of the bronchial tubes may take place and be accompanied by coughing.

Although the common cold begins with the invasion of the body with a virus, its course is complicated by the activity of the bacteria which are present in the nose and throat and which probably give rise to the thick, yellow mucus and the bronchial infection.

Infection is carried in droplets of moisture from the nose and throat thrown out into the air in the actions of breathing out, talking, sneezing and coughing. Any person within range of these droplets will breathe in the germs carried in them so that they will invade his nose and throat. Infection will also be carried on handkerchiefs and fingers after blowing the nose, and on the lips.

2. *Measles*. The first symptoms of another virus disease, measles, appear as a "cold", with running nose and eyes, and this disease is passed on in the same way, by droplets from the nose and throat. It is only a day or so later that the typical rash appears, and by that time the sufferer may have infected a great many people.

3. *Influenza*. A disease which is like the common cold but which is accompanied by a sharper rise in temperature and by aches and pains in the back and limbs is usually called "influenza" by the sufferer. Virologists recognize several types of influenza but only a doctor can tell whether the patient is suffering from one of them. A true influenza may be a serious disease.

The infection is spread in the same way as the common cold. Fortunately, the patient usually feels too ill to work and isolates himself in bed so that fewer people come into contact with him.

4. *Simple Herpes, or, cold sore*. Many people regularly develop a slightly red, itchy, spot on the lip which rapidly develops a blister or a small cluster of blisters. Next day the content of the blisters becomes cloudy and then they form a crust from under which may ooze moisture. The patch heals within a few days.

These cold sores, or simple herpes, usually come when the sufferer is tired, or is developing a cold, or has been sun-bathing, or when there has been a period of very cold winds. Those people who suffer from cold sores were almost certainly infected in early childhood and have retained the virus in the epidermis of the lips all their lives. The virus multiplies in the cells of the skin but

these cells are constantly growing to the surface and being shed and this takes place at the same rate as the multiplying of the virus so that normally no symptoms develop. If, however, the balance is upset by some other factor the virus is stimulated to multiply faster than the skin is shed and causes blisters to appear.

Some people never develop herpes and there seems to be evidence that if a child has escaped infection by the virus until he is five or six, he rarely becomes infected after that. The lips and saliva of the sufferer carry the virus and the infection can therefore be passed on by such things as handkerchiefs, fingers, towels, cups and spoons and by kissing.

5. *Warts* may be of several kinds. The wart most usually seen on the hand is called the common wart and is dark in colour. It is a small lump raised above the level of the skin. It has a rough surface. A large variety of this wart is sometimes seen on the scalp and looks like a piece of cauliflower.

On the soles of the feet warts called plantar warts may occur. They do not look like lumps but they can be felt as a kind of hard core under the skin. They are often painful and give a burning sensation to the sole of the foot.

Another type of wart seen on hands and face is a small, colourless, flat growth. They sometimes occur in groups. They tend to disappear after some years. The virus causing warts acts on the epidermis and part of the dermis, causing them to become greatly thickened. Warts are contagious. Those on the beard region of the face can be spread to other parts by shaving. Those on the feet are often spread from person to person on bathing beaches and swimming pools.

OTHER CONDITIONS SEEN BY THE HAIRDRESSER

1. *Dandruff*

Dandruff is a name which covers several conditions of the scalp.

(a) The topmost, dead, layer of skin all over the body is constantly flaking off. The skin of the scalp is no exception. In some people this flaking is more abundant than in others and if the

hair is not brushed and combed regularly, the dead flakes may accumulate and then show up when at last the hair is combed.

(b) More commonly there occurs a condition in which are found constantly a number of dry flakes of dead skin falling from the scalp however well brushed the hair may be. The bacterium *staphylococcus* and a fungus are seen to be present when the flakes are examined with a microscope, and the condition is considered to be infectious. The name given to it is Pityriasis capitis.

Itching may accompany the condition and scratching will then take place. A secondary infection may result in the form of inflammation, pustules, or an outbreak of impetigo.

(c) The condition described above (Pityriasis capitis) may become inflamed quite apart from any secondary infection following scratching. In this case it resembles to some extent a mild eczema. Pinkish or cream-coloured scaly areas develop on the scalp and there is a slight exudation of moisture from the skin in them. This dries on the flakes of dead skin which fall, giving them a waxy look.

(d) A different condition is caused by the over-activity of the sebaceous glands in the scalp. The hair and scalp are constantly greasy. The face usually also looks oily, especially on the forehead and the nose. The hair follicles may become enlarged to allow the increased amount of sebum to escape and so the skin begins to look coarse. Since there may be ordinary dandruff (Pityriasis capitis) present as well, the flakes of skin will also look oily and greasy. This condition of over-activity of the sebaceous glands is called Seborrhoea.

2. *Eczema*

Is a condition which may occasionally be seen by the hairdresser. The skin of a customer suffering from eczema may show blisters and a dull red, oozing area of skin with dry, crusty or scaly areas associated with it. Eczema is not infectious and is caused by the action on the skin of chemical substances such as soaps, soapless detergents, disinfectants, waving lotions, dyes, cosmetics and scents. No two people react in the same way to these things. In some people the cause of the outbreak may be a particular item of food or a drug taken by mouth so that in this case

the irritation to the skin comes from inside the body and not from outside. In either case the patient is said to show an idiosyncracy towards the chemical or the food and the reaction may continue for a long time after the immediate cause is removed.

The forms of eczema which the hairdresser are likely to see are one which affects the area behind the ear and one which affects areas of strong hair growth and may appear in the beard region or on the scalp.

The hairdresser has a responsibility to discover whether a customer has an idiosyncrasy towards the hair dye she may wish to have used on her hair, and no dye should be applied unless a properly conducted skin test has been carried out.

3. *Dermatitis*

The word "dermatitis" means "inflammation of the skin" and covers many forms of redness caused by irritation by chemicals, heat, light or injury. The inflammation usually disappears soon after the cause of the irritation is removed.

4. *Conjunctivitis*

This name is given to an inflammation of the fine mucous membrane covering the eyes. The eyes look red and sore and in severe cases there is an exudation from the eyes which dries into a sticky crust holding the eyelids together.

There are a number of possible causes for conjunctivitis and some forms are simply due to exposure to biting winds, to sand or dust storms, or to extreme tiredness. But other forms are extremely infectious and the organism concerned may be a bacterium or a virus. A case of conjunctivitis in a customer has been known to cause a severe outbreak which infected every member of the staff of a hairdressing salon and so it is wiser to ask a customer with obviously inflamed eyes not to come into the salon but to wait until the condition has cleared up before asking for an appointment.

Conjunctivitis sometimes follows a prolonged case of dandruff and it is possible that the flakes of skin may have been rubbed into the eye.

THE SPREAD OF INFECTION

Remember than an infectious disease is one that can be passed on from one person to another.

The focus of the spread of an infection will be a person whose body is discharging pathogens. Germs and fungi are not active. They do not walk or fly about by themselves. They are carried about in something which leaves the infected person's body, for example droplets of moisture in the breath; mucus from the nose or throat; faeces; vomit; pus; scabs; flakes of dead skin; hairs.

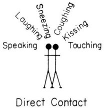
When pathogens leave the body they may:

1. die quickly of dryness, cold or strong sunlight.
2. be washed away and destroyed in sewers.
3. be deposited on hands, lips, clothes, towels, eating utensils, handkerchiefs, tools, food, drink.
4. lie hidden in folds of skin on the fingers, under fingernails, or under smears of grease or lipstick.
5. be shaken into the air and settle in the dust, protected inside specks of dried pus, faeces, scabs or in pieces of hair.

In either of the first two cases they are no longer dangerous, but in all the other situations they are potentially dangerous because at any time they may be moved into a place where conditions are favourable for their reproduction and multiplication, and in this case they may cause infection in a human body.

An infected person may pass his pathogens:

1. to another person close to him. In this case the method of passing on the pathogens will be by droplets from his breath, or by touching the other person with a contaminated part of his body. This is called direct contact.
2. to another person some distance away, even to someone he does not know and whom he may never meet. Something must pass between him and the other person in order to carry pathogens from the one to the other. It may be an object such as a towel or a brush, or it may be an animal such as a fly or a louse. This method of spreading infection is called indirect contact.



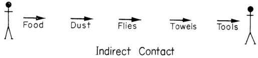


FIG. 124. *The spread of infection.*

We can now see how infection could be spread from one person to others in a hairdressing salon where conditions for such spread are ideal. The atmosphere in a salon is warm and moist, the hairdresser and the client are in close contact with each other, and there are many objects which could carry infection from an infected client to others during the day.

The infection may have its focus in someone already in the salon—a member of the staff—or it may come in from outside—a client, a tradesman or a visitor. But, however it enters, the infection can spread:

1. directly from an infected hairdresser to a client or
2. directly from an infected client to the hairdresser or
3. indirectly from an infected client to others by means of contaminated gowns, towels, neck strips, ear-shields, nets, combs, brushes, rollers, scissors, furniture, pieces of hair, magazines or dust.

PREVENTING THE SPREAD OF INFECTION

1. Under normal conditions the best way to prevent infection spreading in a salon is to avoid the conditions in which pathogens flourish (warmth, moisture, dirt and darkness) and deliberately to provide conditions which inhibit their activity. We can make a list of some of these:

(a) There should be a high standard of health among the staff
(b) A hairdresser with a bad cold or other infection should stay at home
(c) The salon should be well ventilated so that the air in it is as fresh and dry as possible.
(d) All surfaces should be cleaned regularly and thoroughly with detergent and water; grease especially should be removed promptly. (See Chapter 1.)
(e) Dust should be removed with a suction cleaner and this should be emptied outside the salon and the contents burned
(f) Rubbish bins in the salon for hair trimmings, cotton wool and other waste collected during the day should always be covered. Their contents should be burned when they are emptied
(g) Each customer should have clean towels and neck strips. It would be ideal also for each customer to have a clean gown
(h) If cotton wool is used to protect the clients' ears under the dryer, fresh pieces should be used for each client
(i) Each hairdresser should have two sets of tools so that, while she uses one set the other is being disinfected
(j) The practice of placing comb and scissors in the overall pocket defeats any attempt to prevent spread of infection by the use of disinfected tools, because the inside of the pocket becomes contaminated and the clean comb picks up any infection from the last client. The pocket should be replaced by some convenient tray or tool-stand, on which can be placed clean paper tissues to hold tools.

(k) All members of staff should observe a high standard of personal hygiene, and especially with regard to washing hands after using the lavatory and after blowing the nose. Paper handkerchiefs should be used and destroyed at once. Paper handkerchiefs should be provided for child clients.

2. In the case of a specific infection entering the salon more immediate measures will have to be taken.

(a) If the hairdresser notices a serious skin eruption on the client's scalp, face, neck, arms or hands she should not attend to the client's hair but politely suggest that the client visit a doctor and not come to the salon until the condition is cured or until the doctor gives an assurance that the condition is not infectious. Anything that has in the meantime been in contact with the client should be disinfected.

(b) If the hairdresser, while attending to the hair of a child, should notice a condition which she recognizes as, or suspects may be, ringworm, she should draw the mother's attention to the condition and suggest that she should seek medical advice. Then, after arranging the child's hair, she should carefully fold and gather together the gown, neck-strip, towels, and her own tools and remove them. The gown should on no account be shaken because infected hairs will be on it. The gown, towels and the hairdresser's overall should be placed in a bucket and covered with water to which has been added sufficient disinfectant to kill the fungus, and left overnight. She will thoroughly disinfect her tools and gather up the child's hair trimmings carefully so that they do not fly about. They should be burned at once together with the neckstrip. The chair in which the child sat should be wiped down with a cloth wrung out of a solution of disinfectant and the dressing-out table should be washed over. If the child's hair was shampooed the basin should be thoroughly cleaned. All this can be done unobtrusively. The hairdresser should then wash her hands and put on a clean overall.

(c) If the hairdresser notices that the client's head is infested with head lice she should draw the client's attention to this and suggest immediate treatment. The client will almost certainly be grateful to the hairdresser for discovering the condition and will agree to the treatment which can then be carried out. The hair can then be arranged. When the client has gone the hairdresser will carefully gather up the gown, neckstrip, towels and her own tools and overall and disinfect them. She should put on a clean overall.

(d) If, during her work on a client, the hairdresser should notice a discharging ear or a skin condition which she had not noticed before beginning work, then she should finish work on the customer's hair and then disinfect anything which has been in contact with the infected part of the customer's body.

3. Some general points to remember are:

(a) It is not the duty of the hairdresser to diagnose skin conditions which she notices in her customers but she must always remember that she has a duty to prevent infection spreading to other customers and she should treat with suspicion any condition which might be infectious.

(b) Where there is pus there is infection but there is often infection where there is no pus.

(c) Wherever on the body the infective condition may be, it is almost certain that some of the pathogens will be on the hands, because the hands will be constantly touching the affected part. Therefore everything that an infected person touches may carry the infection to someone else.

(d) In many ways the open salon is more difficult to make safe from the spread of infection than the cubicle. A cubicle can be thoroughly cleaned after a client with a suspected serious infection has left without drawing the attention of other customers to the matter; there is not so much danger of infected pieces of hair, or scab or dead skin being blown onto another dressing-out table and magazines can be isolated and destroyed before they are picked up by another customer.

DISINFECTION IN THE SALON

Some explanations of terms concerned with fighting infection may be useful here.

A germicide is anything which kills germs.

A disinfectant is a substance, usually a chemical, which, if used correctly kills pathogens.

An antiseptic is a substance, usually a chemical, which slows down the activity of pathogens but does not necessarily kill them.

Sterilization is the complete destruction of all living organisms in the object or material treated. It can only be procured by great heat or the action of strong disinfectants over a long time.

A deodorant destroys smells or substitutes a pleasant smell for an unpleasant one. It does not kill germs.

A detergent is a wetting and cleaning agent used in water to separate dirt from surfaces. It usually also acts as a mild antiseptic.

The conditions in nature which kill most pathogens are sunlight, fresh air and wind. These are not practical agents to use in a salon except that plenty of light and good ventilation will help to inhibit the activity of pathogens.

Heat is a useful method of destroying pathogens. In hospitals sterilization is carried out with steam under pressure at high temperatures but that is not possible in most salons and so heat in other forms must be used. Burning completely destroys pathogens, and a great deal of rubbish, including hair, is burned every day from salons in incinerators or boiler fires. Boiling is also a useful method and most pathogens will be killed on material which is kept at the boiling point of water (212°F, 100°C), for at least 10 minutes, especially if the cloths and towels being boiled are turned over constantly.

Chemical germicides are the ones most conveniently used in a salon. The constant use of hot water and a detergent to most of the surfaces of the salon is the most effective way of destroying isease organisms because it removes the dirt in which they

breed, and, of course, the towels and gowns are laundered with hot water and detergent.

Other chemicals, however, are used to disinfect tools and materials suspected of being contaminated. The hairdresser will usually find that there are two main kinds of chemical disinfectant provided in the salon—those that go milky in water and those that smell of chlorine. Very few disinfectants are equally effective against all pathogens and towards some pathogens any given disinfectant may act only as an antiseptic.

In order to use a disinfectant correctly the hairdresser should:

1. choose the one which is most effective for the pathogens concerned. Directions from the manufacturer are some guide to this but medical advice is better. Ask the Medical Officer of Health for his advice and keep a list of his instructions.

2. follow exactly the manufacturer's directions about the concentration to be used.

3. choose a dish or receptacle large enough for objects to be disinfected to lie completely immersed.

4. allow plenty of time for the disinfectant to do its work. Some pathogens take a long time to die in disinfectant.

5. when it is time to remove tools from the disinfectant, dry each one on a clean tissue and store in a clean polythene bag or place it in the formaldehyde cabinet until it is required.

The catering trade has recently begun to use chemicals known as *quaternary ammonium compounds* to disinfect utensils and these may prove to be useful as disinfectants in the hairdressing salon because they kill most pathogens quickly and leave an antiseptic film on the object which has been submerged in the solution. They are sold mixed with detergent in a convenient tablet form for ordinary cleaning routines, and instruments such as electric clippers may be held with the head in a solution of this kind for a very short time for disinfection.

Some hairdressing salons are equipped with "*sterilizing*" cabinets in which tools may be disinfected by formaldehyde. Tools should be placed in the cabinet immediately after use on a customer and left for some time before being used again, but probably

the best use for the cabinet is to store already disinfected tools until they are used again.

Some hairdressers use *ultra-violet rays* to disinfect tools and also to act as a deodorant. Suitable fitments for the use of ultra-violet rays in these ways are available.

XXI
PREVENTION OF ACCIDENTS AND FIRST AID

PREVENTING ACCIDENTS IN THE SALON

ACCIDENTS can be prevented by understanding the equipment we handle and by using common sense.

The Salon and Furniture

The salon should be well lit and there should be no dark corners.
The floor should be left unpolished.
The furniture and equipment should be designed and placed to avoid tripping.
The furniture and fittings should be serviced regularly and often.
All hinges, screws and moving parts of equipment should be kept in order.
Any grease and oil which is spilled should be wiped up at once.

Fire Precautions

There should be no naked flames in the salon.
Do not put electric fires where cotton wool scraps and hair could blow into them and ignite.

The advice of the Fire Service should be sought and taken about fire exits, extinguishers and other precautions.
There should be regular fire drill.

Electricity

All electric equipment should be serviced regularly and often.
Plugs should be fitted correctly.
Avoid overloading of power points.
Replace frayed flex at once.
Do not pull out plugs by the flex.
Disconnect equipment from the power supply before examining or dismantling it.
Make sure the switch is in the "off" position before removing a bulb from a light socket or fitting a new one.
The correct strength of fuse wire should be used.
The electricity supply should be switched off at the main switch before the fuse is mended or any investigation of switches is made.
Do not handle electric equipment with wet hands or while standing on a wet floor.

The Dispensary and Store Room

All bottles and containers should be clearly labelled.
Never use chemicals from unlabelled bottles or containers.
Do not put chemicals in bottles commonly used for beverages, e.g. lemonade, squash, or milk bottles.
Follow directions exactly.
Weigh and measure accurately.
Never guess quantities.
Do not keep a naked flame near chemicals or stores of paper towels or cotton wool.
Keep each bottle or container in an appointed place and return each container to its proper place immediately after use.

Care in Working with a Client

Be careful when using hairpins.
Do not allow lotions, shampoos or rinses to run into the client's eyes.
Be especially careful when using scissors near the client's ear-lobes.
Always give a skin test before using dyes.
Wear gloves when tinting and doing a permanent wave.
Some lacquers are dangerous if constantly inhaled. Those with a shellac base should be avoided.

EQUIPMENT FOR EMERGENCIES AND ACCIDENTS

Every salon should have some equipment for dealing with emergencies, illness and accidents and all members of the staff should know where it is and how to use it.

A cupboard or cabinet containing first aid equipment should be easily accessible and should contain:

A box of sterile cotton wool balls.
Gauze bandage, 1, 2, 3 and 4 in. in width.
A packet of lint.
One or two triangular bandages.
Several boxes of prepared dressings of assorted sizes.
Adhesive tape.
Several small packets of sterile gauze.
Safety pins.
Acriflavine or another antiseptic.
A packet of bi-carbonate of soda.
A bottle of vinegar.
A small bottle of castor oil.
An eye dropper.
Scissors.

A small piece of smooth wood or a peg (in case of an epileptic attack).
Smelling salts.
Aspirin.

Keep close to this first aid box the following:

1. a pair of thick rubber gloves for use in case of an accident with electric apparatus.
2. a blanket.
3. a hot water bottle.
4. a clean jug for pouring water into an eye.
5. a small basin for bathing a wound.
6. a beaker or cup from which to give sips of water.

It should be the duty of one member of staff to check the contents of the first aid cupboard regularly and restock it when necessary.

At least one member of staff should know how to carry out artificial respiration and practise it from time to time.

Every member of the staff should know

1. where the main electric switch is.
2. the telephone number of the nearest hospital.
3. how to dial 999 and ask for (a) ambulance; (b) doctor or (c) fire brigade, stating exactly where the salon is, how to get there and the nature of the emergency.

FIRST AID IN THE SALON

Condition	What to Do	Remarks
Abrasion	Bathe the part with soap and water to remove any dirt. Apply an antiseptic and a dressing. A slight abrasion will not need a dressing.	Usually caused by scraping violently against a rough surface.
Acid (a) on skin	Wash the part quickly under a running tap or swill with water. Then make a paste of bicarbonate of soda and apply. Then if serious seek medical help.	

Condition	What to Do	Remarks
(b) in eye	Wash out quickly with a lot of water. To do this put head under the tap *or* pour water from a jug gently over the opened eye, with patient's head over back-wash basin. Keep patient's head turned towards side of injured eye and pour so that water runs across the eye towards outer corner. In this way it will not run into the other eye. Then wash with a weak solution of bicarbonate of soda. A drop of castor oil in the eye will soothe it after washing. Seek medical help quickly if serious.	There may be intense pain and patient will want to keep eye tightly closed. Hold the eyelids wide open gently but firmly. Keep pouring for some minutes.
Alkali		See above.
(a) on skin	Wash quickly under a running tap or swill with water. Then apply diluted vinegar. Then, if serious, seek medical help.	
(b) in eye	Wash with plenty of water as for acid (see above). Then wash with a weak solution of vinegar. A drop of castor oil will soothe the eye after washing. Seek medical help quickly if serious.	
Bleeding		
(a) ear	1. If the bleeding comes from inside the ear after an instrument or tool has been poked into the ear then serious damage may have been caused. Apply a light dressing, but do not plug the ear, and seek medical help. Encourage client to incline head towards the side that is bleeding. 2. If the bleeding comes from outside parts (e.g. the lobe) of the ear it will be from a scratch or cut. Apply an antiseptic and a dressing. The cut is not likely to be serious although it may bleed freely.	

Condition	What to Do	Remarks
	3. If the bleeding comes from inside the ear but nothing has been done by the hairdresser to cause it, then apply a light dressing to the ear and suggest that the client see a doctor.	
(b) lip	Wash with cold water. If cut is long, hold edges of cut together for a few minutes.	Usually caused by biting the lip.
(c) nose	Seat the patient comfortably, ask her to breathe through her mouth and bend her head forwards, then hold nostrils together for some minutes until a clot forms and the bleeding stops.	If the head is held back, the blood will run down the throat and may cause vomiting. It may be difficult to persuade a child to hold her head forward. If so, let her sit upright and try to persuade her to hold her nose. A cold compress on the bridge of the nose helps.
(d) wounds	See Cuts and Puncture Wounds.	
Burns (a) from hot metal or fire	1. If slight, the skin will be red but there will be no blistering. Run cold water from tap over burn to reduce pain. Cover the reddened area with a paste of bicarbonate of soda and water and a dry dressing. 2. If moderately severe (e.g. if blisters form) cover with a clean dry dressing, keep the patient warm and take to a doctor.	

Condition	What to Do	Remarks
	3. If severe, cover the area of the burn quickly with a clean dressing or cloth. Do not breathe over the burned area or touch it with the hands; keep patient warm, give a drink and send at once for doctor or ambulance.	
(b) chemical burns	See *Acid* and *Alkali*.	
(c) electric burns	Caused by contact with a "live" wire. Treat as for a burn caused by fire but see also *Electric Shock*.	
Concussion	Comes from a blow on the head (e.g. striking the head on a piece of furniture after tripping or slipping on a greasy floor). The patient may be unconscious for a short time. Lay her down and keep her warm. She may vomit and feel dizzy. Keep her quiet and send for a doctor.	Do not leave the patient alone because she may not know what she is doing.
Cuts (a) slight	Wash with water and put on a dressing. If cut is bleeding freely, hold sides of cut together with clean fingers for a few minutes and then apply dressing.	
(b) severe	Stop the bleeding by applying a pad of clean gauze and bandage firmly. Take to a doctor or hospital for possible stitching. If an artery is cut the blood will come out in vigorous spurts. Apply a pad of something (e.g. handkerchief) quickly to the cut and hold it there very firmly until medical help comes. Any laceration of the scalp will bleed freely.	
Electric Shock	If the patient is still in contact with the electrical apparatus the main supply switch must be turned off. If this is impossible do one or other of these things:	*It is important not to stop artificial respiration.* If you are alone, do NOT

Condition	What to Do	Remarks
	1. Put on thick rubber gloves and pull her away. 2. Stand on a *dry* rubber mat and pull her away. 3. Push her away with a *wooden* chair or broom handle (*not* metal). 4. Push her with a folded blanket or several layers of newspaper rolled up. If breathing has stopped apply artificial respiration and send for medical help. When breathing is established make patient warm and comfortable and keep her quiet until help comes. Treat the burns.	STOP to telephone for help. If there are other people present send one to telephone and then, if necessary, take it in turns to carry out artificial respiration·
Epilepsy	A form of unconsciousness which is accompanied first by rigidity and then by convulsions. The patient may fall heavily to the floor, later twitch violently and thresh about with the legs, and froth may be seen at the mouth. Place a pencil covered with a handkerchief in her mouth across the teeth so that she cannot bite her tongue. Loosen clothing and allow fresh air to reach the patient. Support the head to prevent its being hurt during convulsions. After about five minutes or less, the patient will regain consciousness but she will feel sleepy and exhausted. Keep warm and quiet. Remember that the fall to the floor at the outset of the fit may have caused some damage to the head or limbs.	Since epilepsy is a disease in which these attacks (fits) occur at intervals the patient may carry with her tablets to take if she recognizes the earliest symptoms of the attack. If the attack has been a severe one the patient should be escorted home.
Fainting (a) if patient feels faint but is not unconscious	Put patient's head between her knees or lay her down with feet raised. Loosen tight clothing. Open a window nearby or fan the face with a newspaper but cover patient's body with a coat or rug. Apply smelling salts to nose. When patient recovers, give her a hot drink.	May occur (a) suddenly if client gets a fright or a sudden bad pain. (b) gradually if she has been ill or is overtired or if the salon is hot and stuffy.

Condition	What to Do	Remarks
(b) if she becomes unconscious	See *Unconsciousness*.	
Foreign body in the eye		
(a) hair or dust	If under lower lid, pull lid downwards gently while patient looks upwards. If the hair or speck of dust can be seen remove it with the corner of a clean moistened handkerchief or a twist of clean cotton wool. If under the upper lid, ask patient to look downwards and turn the upper lid backwards over a clean matchstick held across the lid; if the hair or grit can be seen, it may be removed with a handkerchief or cotton wool. If the eye is sore after the foreign body has been removed, put a drop of castor oil in the eye. If the foreign body cannot be found and is still troublesome, cover the eye with a light dry dressing and take patient to doctor or hospital.	
(b) chemical	See *Acid and Alkali*.	
Fracture	After a fall a limb may be fractured. The signs and symptoms of this are pain, tenderness, loss of use of limb, distortion and swelling. The distortion may not be very noticeable. Keep the patient warm, support the injured limb as much as possible without moving it too much and send for a doctor or ambulance.	Do not give anything to drink because the patient may need an anaesthetic while the limb is being set.

Condition	What to Do	Remarks
Heart attack	Do not leave the patient but send for medical help. Support patient in a sitting position and prevent her falling forward. Undo tight clothing. Search her handbag and pockets for crushable glass capsule which she may carry with her. Break this in folds of a handkerchief and hold under her nose. If she carries tablets put one under her tongue.	May occur (a) suddenly, with severe pain, patient's face ashen. (b) after exertion, with breathlessness. Patient's face may be blueish, especially round the lips. She may collapse and show signs of severe shock.
Hysterical attack	Patient may laugh or cry uncontrollably. She may clutch other people or tear her hair or roll on the ground. She will not become completely unconscious. If you are sure it is hysteria speak firmly to patient, take her out of the salon into another room and stay with her until she has regained control of herself. Give her something definite to do such as brushing her clothes or tidying her handbag or restoring her make-up.	Attacks of this kind occur most often in women of a "highly strung" type. They do not occur when the person is alone but they are performances demanding an audience.
Poisons *Swallowed* (a) Burning Poisons		
(i) Ammonia	Give plenty of water to drink quickly. send for medical help at once. Do not make the patient vomit. Keep the bottle for the doctor to examine.	Burning (or corrosive) poisons can be easily identified because the lips and

Condition	What to Do	Remarks
(ii) Disinfectants that smell of carbolic	Give plenty of water or milk to drink quickly. Send for medical help at once. Do not make the patient vomit. Keep the bottle to show the doctor.	mouth of the patient show white burns and the patient is in very great pain and collapses with shock.
(b) Non-burning poisons (usually overdoses of aspirin codeine, or sleeping tablets)	If she is conscious try to make patient vomit by pushing your fingers down her throat or by making her drink a tumbler of warm salty water (about 2 tablespoons of salt), then take her to a hospital quickly. Take the bottle which held the tablets with you. If she is already unconscious, keep her warm and send for medical help.	Ammonia or carbolic disinfectants have strong smells which help in the indentification.
Puncture Wound	This is likely to be slight in a salon and may be caused by a hairpin or clip being roughly pushed into the scalp. It will bleed freely. Wipe the blood away and hold on a firm dressing until bleeding stops. If it is more serious (such as an accidental stabbing with scissors) it should be covered with a clean dressing held very firmly, and be seen by a doctor. A deep puncture may not bleed much.	
Scalds	As for burns.	Scalds caused by steam are more severe than those caused by hot liquids.
Sprains	Apply cold compresses for a few minutes and then bandage firmly and take patient to hospital for X-ray to make sure the injury is not a fracture.	Symptoms and signs are tenderness, aching, swelling and perhaps bruising

Condition	What to Do	Remarks
Unconsciousness		
(a) Diabetic coma	Search pockets or handbag for a card—stating she is a diabetic and what to do. Known diabetics usually carry these. Keep warm and send for medical help.	May be one of two kinds (1) skin dry, breathing deep and sighing, breath smells of musty apples or nail varnish. May be deeply or only lightly unconscious. (2) skin moist with perspiration, breathing shallow and quiet, breath does not smell. May be excited before becoming unconscious or may only be faint.
(b) *Fainting*	Lay her down with head lower than feet. Loosen clothing. Open window or fan her but keep her warm. On recovery give her a drink of water or tea.	Usually recovers rapidly.

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GLOSSARY AND INDEX

ABDOMEN That part of the body below the diaphragm in which lie the liver, kidneys, intestines and bladder. 15, 18

ABRASION A scraping off of skin from an area on the surface of the body. 244

ACID A corrosive substance usually, which turns blue litmus paper red. Reacts with a base to form a salt and water. Acetic acid. Citric acid. 113–114

ACNE A skin condition in which are seen "blackheads" and pustules. 227

ACRIFLAVINE A mild antiseptic, yellow in colour. 243

AIR SAC A very small, thin-walled bag, surrounded by blood vessels, in the lung. There are a great many air sacs in each lung. 22, 23

ALIMENTARY CANAL The tube in the body which has the mouth at one end and the anus at the other. It is concerned with the digestion and absorbtion of food material. It is wider in some parts than in others. Also called the digestive tract. 21

ALKALI A base dissolved in water. Turns red litmus paper blue. Sodium Hydroxide (caustic soda); Potassium Hydroxide (caustic potash); Ammonium Hydroxide. 113, 119

ALTERNATING CURRENT The usual current generated by power stations and supplied for domestic use. This current fluctuates between negative and positive so many times per second. 171–172

ALUM The sulphate of potassium and aluminium (Potassium aluminium sulphate). An astringent, used as a styptic.

AMINO-ACIDS A compound of carbon, hydrogen, oxygen and nitrogen; the "bricks" from which protein molecules are built. 146

AMMONIA A colourless choking gas which dissolves in water rapidly to form a strong alkali called Ammonium hydroxide. 119

AMPERE The unit in which the amount of electricity is measured (rate of flow). 176–177

ANAEMIA A disease, or condition, in which there are not enough red corpuscles in the blood.

ANAGEN A period of active growth and development in a hair follicle. 60, 61

ANTI-BODIES Substances which develop in the blood when the body is invaded by a disease organism (pathogen). They help the body to resist the infection. 26, 225

ANTISEPTIC A chemical substance which can slow down the activity of pathogens. 238, 239, 243ff.

ANUS The opening at one end of the alimentary canal through which food material the body has not used is ejected. 21

APOCRINE GLANDS A type of large sweat gland which develops at puberty in the arm pits and in some other parts of the body. 50, 57, 203

APONEUROSIS A sheet of tendon. 39, 46, 47
ARRECTOR PILI MUSCLE A small muscle attached to a hair which, when it contracts, pulls the hair into an upright position. 56, 57
ARTERY A large blood vessel which carries blood from the heart. 27, 28, 247
ARTIFICIAL RESPIRATION A method of restoring breathing to a patient who has been apparently drowned or electrocuted. 244, 247, 248
ASTRINGENTS Substances which tighten the skin—such as Witch Hazel, Alum; cold water has an astringent effect. 135
ATOM The smallest particle of an element, composed of a nucleus surrounded by electrons. 68–69
AURICLES The two upper chambers of the heart. They receive blood, the left from the lungs and the right from the body, and pass it to the lower chambers (the ventricles). 27, 28
AXIAL SKELETON The skull, backbone and rib-cage. 13

BACK INLET GULLY A form of gully trap where the waste pipe comes in at the back instead of at the top. 7
BACTERIA Minute living organisms some of which cause disease in man. 44, 216, 222ff.
BACTERIOLOGIST One who studies bacteria. 223
BALANCE SYSTEM A method of ventilating shops and salons and other large buildings where stale air is drawn out by one large fan and fresh air is driven in by another. 102
BASE A metal element combined with oxygen which if dissolved in water is called an alkali. 112
BATTERY An apparatus containing two or more cells for generating electricity by chemical means. 159, 163
BEVERAGES A liquid used as a drink e.g. tea, coffee, lemonade. 200
BILE A fluid made in the liver. It is stored in the gall bladder and passes down the bile-duct into the duodenum when needed to help digest food. It is used particularly in the digestion of fats. 20
BLADDER An organ in which urine from the kidneys is stored until it is evacuated. 17, 19, 25
BLEACHING SOLUTION Hydrogen peroxide with a small amount of ammonia solution added to decompose the peroxide. 155
BOIL An inflamed lump in the skin caused by the reaction of the body to an invasion of staphylococcus. Pus is present. 227
BOILING That process that takes place at one temperature (e.g. 100 °C for water) when maximum evaporation takes place. 30
BONE Hard substance from which the skeleton is made. It is made up

of cells embedded in a material made of "bone salt" in which the main ingredients are calcium and phosphate. 13ff., 35ff., 203

BORAX Sodium tetraborate—a white powder used as an antiseptic and cleansing agent. Also, at one time used in heat permanent waving outfits in paste form. 122, 141

BORIC ACID Used as an antiseptic dusting powder. In liquid form used in eye lotions.

BOTTLE-TRAP A section of pipe underneath a wash basin in which a short pipe lies within a wider one in which there is a water seal. 6

BRAIN The organ which is the centre of sensation, thought, reason and memory; that part of the nervous system which is contained inside the cranium. 12, 17, 18, 29, 32

BREACH A breaking open; a broken gap.

BRILLIANTINE An oily substance that gives lustre to the hair. Made from mineral oils. 124

BRITISH THERMAL UNIT The amount of heat required to raise the temperature of 1 lb of water through 1 °F. 73

BULB (OF HAIR) The mass of cells at the base of a hair follicle from which the hair grows. It is fitted over and around the dermal papilla. 56, 58ff.

CALAMINE LOTION Zinc carbonate in alcohol used for treatment of dermatitis. 177

CALORIE The amount of heat required to raise the temperature of 1 gramme of water 1 °C. 73

CAMOMILE Herb flowers used in brightening rinses. 152

CAPILLARIES Minute blood vessels which branch throughout all the tissues of the body and carry blood from arteries to veins. 27, 48

CARBOHYDRATES Sugars and starches. They provide warmth and energy for the body when they are digested. 62, 199, 201

CARBOLIC Describes phenol (carbolic acid), a disinfectant which has a strong smell. It is soluble in water and is poisonous and corrosive. Goes milky in water. 251

CARBON Non-metallic inactive element found in soot. 111

CARBON DIOXIDE A colourless gas breathed out by man. 112–113

CARTILAGE Firm, supporting tissue in the body, not as hard as bone; gristle; e.g. the lower end of the nose and the ears are formed of cartilage. 37

CATAGEN The state of changing from active growth to resting in a hair follicle. 60, 61

CAUSTIC A term describing a substance that tends to burn the skin. e.g. Caustic soda—sodium hydroxide. 119

CELL (IN THE LIVING BODY) A very small, separate mass of protoplasm surrounded by a membrane. The human body is made up of about a million million cells, grouped into different tissues. 12

CELL (IN PHYSICS) An arrangement for producing an electric current by chemical action. 159

CEREAL An edible grain e.g. wheat, oats, barley, rye. 201

CHANGE OF STATE When matter is heated it tends to change its form, from solid to liquid to gas. e.g. Melting and evaporation. 73

CHLORINE A poisonous gas with a sharp, pungent smell. 239

CIRCUIT A path of an electric current. 173

CIRCUIT, SHORT A current changed from its usual circuit which results in a blown fuse. 182

CIRCULATION SYSTEM A series of tubes in the body which carry blood all round the body. 28

CLEANING EYE A cap on a waste pipe which can be unscrewed to allow the pipe to be cleaned. 6, 7

COCCUS A round-shaped bacterium. They sometimes occur in clusters e.g. *Staphylococcus* or in chains e.g. *Streptococcus*. 226

COCCYX The small "tail" in which the backbone ends. It is made of the last four vertebrae fused together. 13

COLD COMPRESS Cloth wrung out of cold water and held on to an injured part of the body. 251

COLD WAVE LOTION A chemical solution of a reducing agent that softens the hair in cold waving. 147, 149–150

COLLODION A solution which forms a film when exposed to air and is therefore useful in protecting a scratch or small cut in the skin. 204

COLON The large intestine. 17, 19

COLOUR RINSE A rinse which gives the hair a temporary tint by coating the hair shaft. 155

COLOUR SHAMPOO A preparation which colours the hair either permanently or semi-permanently without requiring a pre-softening treatment. 155

CONCUSSION A bruising of the brain caused by a blow on the head, or by the head striking a hard surface. 247

CONDENSATION This is the name given to the process whereby hot vapour changes back to a liquid when coming into contact with a cold surface. 104, 133

CONDUCTION This is a process whereby heat or electricity is conducted or led along or through matter, e.g. Good conductor of heat and electricity—copper. 82, 90, 176, 208, 209

CONJUNCTIVITIS Inflammation of the mucous membrane which covers the white of the eye and lines the eyelids. 232

CONNECTIVE TISSUE Tissue made up of fibres which supports and packs around other tissues. 39

CONTAGIOUS DISEASE A disease which can be passed on from the sufferer to someone else. A disease which can be "caught"; see "Infectious". 225

CONTAMINATE (to) To infect; to make dangerous by exposing to germs. 233, 234

CONTRACT (to) To draw together e.g. when we frown the frontalis muscle contracts. 15, 16

CONVECTION This is the name given to the resulting movements of liquids or gases after they have been heated. Hot liquids or gas become less dense and thus "rise". Convection is one mode of heat travelling. 83, 90ff.

CONVULSION A fit; a violent lashing about of arms and legs without the control of the patient. 248

CORNIFIED Turned into a horny, hard material called keratin. 42

CORPUSCLES (Blood) Cells which are found in the blood. They are of two main kinds (1) red corpuscles which are shaped like hollowed discs and which contain haemoglobin and (2) white corpuscles which have no rigid shape and which fight disease organisms in the body. 26, 225

CORROSIVE Capable of burning away tissue and so destroying it. If a corrosive poison is swallowed the tissues of lips, tongue, mouth, throat, food-tube and stomach are damaged. 250

CORTEX The main layer of a hair; the part surrounding the middle core (or medulla). 53ff., 154

CRANIUM That part of the skull which holds the brain. It is a curved, bony box. 35, 36, 38

CUTICLE An outside layer covering an animal or plant. In the hair it is the outermost, thin layer and it is made up of overlapping scales. 53, 54, 154

CYSTEINE Reduced cystine such as occurs during perming with reducing agents, such as sodium sulphite, ammonium thioglycolate. 149

CYSTINE An amino acid containing sulphur. Found in keratin of hairs and nails. 148

DANDRUFF A condition of the scalp in which there is a continual fall of small flakes of dead skin. 230, 231

DENSITY The density of matter is determined by dividing the volume (in ml or cm^3) into the weight (in grammes) $= \frac{\text{weight}}{\text{volume.}}$ 70

DEODORANT A substance which destroys smells or substitutes a pleasant smell for an unpleasant one. 238, 240

DEPILATORY A substance which removes hair, calcium thioglycollate. 150

DEPOLARIZATION This is the procedure of removing gas bubbles, which cause a drop in voltage from round the positive electrode of chemical cells. 161

DERMAL PAPILLA A projection of the dermis into the epidermis. Dermal papillae occur along the junction of epidermis and dermis; there is a dermal papilla projecting into the epidermis at the base of a hair. 19, 47, 56ff.

DERMATITIS An inflammation of the skin which is caused by irritation by chemicals, heat, light or injury. 232

DERMIS The lower, and thicker, of the two layers of the skin. 46ff., 56ff.

DETERGENT A substance which separates grease from a surface e.g. soap, shampoo, etc. 4, 137, 142, 143, 238

DIAGNOSE (to) To recognize a condition from the evidence of symptoms and signs. 237

DIAMETER The distance across the middle of a circle.

DIAPHRAGM A sheet of muscle and tendon which separates the chest space from the abdomen space in the human body. 17, 18, 24, 25

DIGEST (to) To break down food material with the help of "digestive juices" into simple forms which the body can use to produce energy and to build and repair itself. 19, 20, 21

DIGIT Finger or toe. 15

DILATE (to) To enlarge; to make or to become wider or larger.

DILUTE (to) To add water, or another solvent, to a solution.

DIRECT CURRENT This is the type of current which does not fluctuate as does a.c. It is produced by dynamos fitted with commutators and brushes. 172–173

DISEASE An illness or sickness. 32, 199, 216ff.

DISINFECTANT A substance, usually a chemical, which can kill germs if it is used correctly. 5, 238

DISPENSARY In a hairdressing business, the room in which chemicals are stored and solutions prepared for use in the salon. 242

DISTILLATION This is the process of purifying liquids by first evaporating and then condensing. 132

DUCT A tube or channel.

EARTHING Earthing is a method of leading away dangerous currents into the earth to prevent shocks. All electrical apparatus should be earthed. 188–189

ECZEMA A skin condition in which there occur blisters, areas of moist, red skin and dry crusts. It is not infectious but is caused by individual reactions to substances such as soaps, dyes and cosmetics. 231

ELASTIC Springy; able to go back to its original shape or bulk after stretching. 43, 48, 146

ELECTRODE An electrode leads electricity to or from a piece of apparatus. The electrodes of a primary cell lead away the electricity produced in the cell.
The electrode in a voltmeter leads electricity into an electrolyte. Electrodes become negatively or positively charged. 161

ELECTROLYTE An electrolyte is usually a liquid containing dissolved salts and an acid. The dissolved substances are present in the form of charged ions, thus an electrolyte conducts electricity. e.g. Electrolyte of a dry cell—ammonium chloride. 161

ELECTROMAGNET An electromagnet is a magnet produced by passing an electric current through a coil of wire wound around the metal being magnetized. 169, 185–187

ELEMENT The purest form of matter composed of the same types of atom. Elements may be non-metal or metal. 111

ELIMINATION Getting rid of something. (Usually used of waste matter in the body.) 25

ELONGATE To make or to become long.

EMOLLIENT A substance which softens the skin e.g. glycerine or lanolin.

EMULSION An intimate mixture of two liquids which under normal conditions are immisable. e.g. Oil in water. 125

ENVIRONMENT Surroundings.

EPICRANAL On top of the cranium. 37ff.

EPICRANIAL APONEUROSIS A sheet of tendon which covers the top of the head. With the skin above it, it forms the scalp. 37ff.

EPIDERMIS The outer of the two layers of the skin. 46ff., 55ff.

EPILEPSY An illness in which there occur periods of unconsciousness with violent twitching of the limbs ("fits"). 248

ERUPTION Outbreak.

ESSENTIAL OIL Oils that are used in perfuming are known as essential oils. These oils are obtained from plants, e.g. oils of lavender, peppermint, rose, etc. 123–124

EVACUATE (to) To empty.

EVAPORATION This is the process of changing state from a liquid form to a vapour form. This takes place at most temperatures, but proceeds rapidly at boiling point. 30, 81 208, 209

EXCRETE (to) To separate and send out of the body as waste material. 25

EXHAUST SYSTEM A form of ventilation where stale air is sucked out by fans and fresh air comes into the room naturally. 102

EXTRACTOR FAN A fan which sucks out stale air from a room. 102

EXUDE (to) To ooze out. 231

FAECES Unused food and waste in the bowel. 224, 233
FESTERING Development of inflammation and pus following an invasion of disease organisms into the body through a break in the skin. 221
FIBRE A thin, thread-like strand of material. 210
FIBROUS Stringy; made up of fibres.
FLEA An insect which sucks blood. It has long back legs which enable it to jump long distances compared with its size. 222
FLUE A chimney designed to draw off fumes. 94
FOETUS The unborn child. 62
FOLLICLE The pit in the skin from which a hair grows. 50,55ff
FORMALIN A pungent gas called Formaldehyde dissolved in water to form a disinfecting solution. This solution is usually 37–40 per cent formaldehyde. 125–126, 239
FRACTURE A break, especially in a bone. 249
FRONTAL BONE The bone forming the forehead of the human head. 36ff
FRONTALIS MUSCLE The muscle over the forehead which, when it contracts, pulls the scalp forwards 37ff.
FUNCTION The work something is meant to do.
FUNCTION (to) To work. An organ functions when it carries out the work it is designed to do and so contributes to the working of the whole body. 44, 63
FUNGICIDE Anything which kills a fungus. 218
FUNGUS A member of a group of plants which have no green colouring matter. They include moulds, yeasts and mushrooms. 216ff.
FUSE A piece of wire in an electric circuit made of a different metal from the rest of the circuit. It melts as soon as the current becomes too high thus breaking the circuit and preventing the rest of the wiring from being damaged. 182

GAUZE Loosely woven cotton material used for dressing and bandaging wounds. 243,247
GERM (Root Germ; germ for new hair) see "GERMINAL MATRIX" 61
GERMICIDE Anything which kills germs. 238
GERMINAL MATRIX The part of an organ from which new cells are constantly developing (e.g. the part of the nail from which it grows outwards). 51
GERMINATE (to) To begin to develop. 217
GERMS Microscopic organisms which cause disease in man; usually bacteria and viruses. 222ff.
GLAND An organ in the body which makes a particular chemical

substance which is then released from the gland (e.g. digestive glands and sweat glands). 19ff., 48ff.

GLYCERINE A transparent oily liquid used in creams and other skin preparations. 137–138, 140, 144

GRANULE A small grain of matter.

GULLY TRAP A wide pipe in the ground at the bottom of a waste pipe. It contains a water seal and is covered with a grating to catch solid matter such as hair. 7

HAEMOGLOBIN Colouring matter found in the red corpuscles of the blood. 22, 23, 26

HAIR ROOT A bulb-shaped group of cells in the base of a hair follicle which develop from the layer of epidermal cells around the dermal papilla under the follicle. The hair grows upwards from this bulb. 57ff.

HARD WATER Hard water is of two types—temporary and permanent. Such water will not allow soap to lather well because of the scum formed due to the calcium salts dissolved in the water. 129

HEART A muscular organ of the body situated in the chest. It pumps the blood round the body. 11, 15ff., 22, 27, 28, 30, 32

HEAT This is a form of energy which may be measured by noticing the rises of temperature of objects when they have heat applied to them. 73, 90ff.

HERPES (SIMPLE) A skin disease caused by a virus. It takes the form of blisters on the lips. 229

HORMONES Substances formed by special glands in the body and transported to other parts of the body where they exert an influence on the work of the organs. 26

HOST A living organism at the expense of which another organism lives. This second organism is called a parasite. An example is the fungus which draws its nourishment from the human skin and causes the disease of ringworm.

HUMIDITY The amount of water vapour present in the atmosphere.

HYDROMETER This is an instrument used for measuring specific gravities of liquids—that is comparing the density of one liquid with the density of water. 71–72

HYSTERIA A nervous condition in which there may occur mild convulsions. The patient loses control of herself and may laugh, cry and roll on the ground. She does not completely lose consciousness. 250

IDIOSYNCRACY The reaction of the body of an individual to such substances as soaps, dyes and cosmetics. 232

IGNITE (to) Set fire to; takes fire; set alight; begin to burn.

IMMINENT To happen soon.

IMMISCIBLE Will not mix. 125

IMPERVIOUS (to water) Does not let water through. 2, 3

IMPETIGO An infectious disease of the skin in which there are pustules and yellow crusts. 220, 221, 226

INDUCTION COIL An instrument which generates high voltage and low current. 194

INFECTION The successful settling in the body of disease organisms. 216ff.

INFECTIOUS Capable of spreading disease. 216ff.

INFESTATION An attack on the body by small animal parasites (e.g. head lice or itch mites). 216, 220ff.

INNER ROOT SHEATH A protective sheath formed round a growing hair by cells from the matrix of the hair root. 56ff.

INSPECTION CHAMBER A place, in the ground near a building, where, on lifting a heavy cover, the drains may be inspected. Drains from waste pipes and soil pipes join here. 7

INTERPRET (to) To make out the meaning of.

INTESTINES Bowels; the part of the digestive tract between the stomach and the anus. Absorption of food material takes place in the intestines. 17, 19ff., 41

INVASION (of the body) An inroad into the body of something harmful to it.

ION An ion is an atom with a negative or positive charge found in solutions and some solids and salts.
Substances dissolved in liquids usually ionize, that is "break up" into ions. 162

ITCH MITE A small eight-legged animal which burrows and lays eggs in tunnels in the skin of the human body. 222

JAUNDICE A disease which involves the liver. Bile enters the blood stream causing the skin to look yellow. 43

JUNCTION A joining.

KERATIN A hard, tough material which forms the outer layer of the epidermis and also occurs in hair and nails. 46, 59, 146

KILOWATT (1 kW) One thousand watts power. 1 Kilowatt per hour is one unit of electricity.
1000 watts = 1 Kilowatt
1 kWh = 1 unit of electricity. 179

KIDNEY An organ which excretes waste material from the body in the form of urine. 11, 17ff., 25, 26, 201

LACERATED Torn or shredded.

LACERATION A tearing or ripping of tissue (such as skin or flesh).

LANETTE WAX An emulsifying agent. 125

LANOLIN A purified wool fat. 74, 141

LANUGO HAIR Fine, soft hair which grows on the unborn child. 62, 63

LARYNX Wide part of windpipe in which are the vocal cords which enable us to make varied sounds and therefore to speak. "Adam's apple". 17, 18

LICE Insects which feed on the human body by sucking the blood. Some live mostly on the head, others on the body. 220ff.

LINT A soft material fluffy on one side, used for dressing wounds. 243

LIVER An organ of the body which stores food, sorts and alters it, produces bile and makes certain dangerous waste products harmless. 11, 17ff.

LOUSE An insect which feeds on blood. It is an external parasite of man. Some types live on the head, others on the body. 221ff.

LUBRICATE (to) To make slippery by the use of a greasy or oily substance. 2

LUNGS Organs for breathing air. The human body has two lungs. 15, 17ff., 22ff.

MATRIX The lower part of the bulb of the hair root. The cells in the matrix all look alike and they are constantly dividing into two and being pushed upwards. 56ff.

MATTER Matter is any substance that occupies space and has weight. 68

MANURE The faeces of animals, used to fertilize the soil; dung. 2

MEASLES An infectious disease caused by a virus. It is accompanied by fever and a characteristic rash. 229

MEDULLA The central core of a hair. 53ff.

MELANIN A brown pigment (colouring matter) found in skin and hair. It can give yellow, light or dark brown colouring according to how much of it there is in the cells. 50, 55, 63

MELTING This is the process of changing from a solid state to a liquid state due to the application of heat. 79, 81

MEMBRANE A sheet of material that encloses a structure or lines a cavity in the body. Membranes can be of many different thicknesses, e.g. the membrane surrounding a single cell is made of protein and fat and is very thin; the membrane lining the nose, mouth and throat is a sheet of cells (see also Fig. 4, page 12). Such a membrane often secretes mucus and is then called a mucous membrane. 22, 232

MINERALS Non-living substances found naturally in the earth. Small amounts of some minerals are found in our food (e.g. iron and calcium) and are necessary for the growth and health of the body. 199, 202

MINERAL OILS These are oils which have their origin in rocks. Such oils as petroleum or paraffin are mineral oils. 124

MOLECULE A molecule is a group of two or more atoms. For example, a molecule of water is two hydrogen atoms joined with one oxygen atom. 68–69

MOULD A form of fungus in which can be seen the growth of threads (mycelium) which make up the main part of the fungus. 216ff.

MUSCLE A tissue made up of cells which can contract. Muscle is what we ordinarily call "flesh". 15, 16, 31, 33, 34, 37ff., 56

MYCELIUM The mass of fine threads which make up the main part of a fungus (apart from the reproducing parts). 217

NAIL A protective sheath growing from the epidermis at the end of a finger or toe. 51

NASAL Having to do with the nose.

NERVE FIBRE A small bundle of nerve cells. 29, 31, 32, 49, 57

NEUTRALISATION A chemical term decribing the process of salt formation by acid alkali mixture. 114

This terms is used by hairdressers to refer to the process of oxidising the hair linkages after perming with cold wave lotions. 149, 150

NIT The egg of the head louse. 220

NUTRIENT That part of food which the body uses, e.g. proteins and carbohydrates are nutrients. 199, 201

OCCIPITAL BONE The large curved bone forming the back of the cranium close to where it joins the backbone. 36, 38

OCCIPITALIS MUSCLE The muscle covering the occipital bone. The scalp is attached at the back of the head to this muscle. 38, 39

OESOPHAGUS The food-tube, leading from the mouth to the stomach. 17, 18, 20

OHM The ohm is a measure of electrical resistance—$\frac{\text{volts}}{\text{amperes}}$. 178–179

OPTIC Having to do with the eyes. 32

ORBITS The bony hollows in the skull in which the eyes are situated. 37

ORGAN Part of the body which does a particular piece of work, e.g. heart, kidney, liver. 11, 12, 17

ORGANISM An individual living unit, i.e. an animal, a plant, a bacterium, a virus. 216ff.

OUTER ROOT SHEATH The walls of the follicle which protect the growing hair. 56ff.

OVERLOADING A demand upon electric circuit to carry too much current. This may be brought about by plugging in too many pieces of apparatus into one socket. Overloading will cause the fuse to "blow". 183

OXIDATION This is the process of adding oxygen to matter to form oxides. 112

OXIDE Metal oxide, e.g. calcium oxide
(Base) (Quicklime) 112
Non metal oxide, e.g. carbon dioxide
(acidic oxide).

OXYGEN An invisible gas with no odour; it forms one-fifth of the atmosphere and is essential to living organisms. 12, 21ff., 62, 99, 109, 223

PANCREAS A large gland near the stomach which secretes a digestive juice. 20

PARA-DYE Para-phenylene diamine and Para-toluylene diamine are oxidation dyes which form large permanent colour molecules in the hair shaft cortex. 153, 154

PARASITE An organism which lives at the expense of another organism (the host), e.g. the fungus of ringworm.

PARIETAL BONES The two flat bones, one on each side, on the top of the head. 36

PARTICLE A very small portion of matter.

PATHOGEN An organism which causes disease, or suffering. 216

PELVIS That part of the abdomen surrounded by the hip-girdle. 15

PERMANENT WAVING A process whereby the molecular linkages of the hair are re-arranged by means of reducing agents such as:
(a) Sodium sulphite—heat waving 146–151
(b) Ammonium thioglycollate—cold waving.

PERMUTIT This is a chemical called sodium aluminium silicate used as a water softener for softening temporary and permanent hard water. 131

PEROXIDE Hydrogen peroxide (H_2O_2) the reagent that supplies oxygen for bleaching, oxidation tints and "neutralization". 117–119

pH The symbol for hydrogen-ion concentration. Indicates the relative degree of acidity or alkalinity. 113

PHAGOCYTES White corpuscles which destroy germs by engulfing them. 225

PHARYNX The upper throat and back of the nose. 17

PHLEGM A thick, sticky mucus produced by the lining of the throat and windpipe, especially when it is attacked by germs (e.g. of the common cold). 2

PIGMENT Colouring matter. 50, 53, 54

PITYRIASIS CAPITIS A common form of dandruff. 231

PLASMA The salty liquid of the blood in which float the red and white corpuscles. Blood plasma can clot. 26

PLASTIC A man-made material which can be moulded into different shapes. There are many different types. 204

PLATELETS Very small bodies found in blood which help it to clot when a blood vessel is cut. 27
PLENUM SYSTEM A system of ventilation in which air is drawn in by fans, freed from dust, and blown under pressure into the room. 102
POLARIZATION This is a process whereby hydrogen bubbles around the positive electrode in a cell cause a drop in the voltage of the cell. 161
POLLEN Very small spores of flowering plants, usually seen as a fine, yellow dust. 2
POROUS Full of very small holes.
POSTICHE A piece of added hair used in boardwork.
POTASSIUM HYDROXIDE The caustic alkali used in the preparation of soft soap. 120, 138
PRIMARY CELL (Physics) This type of cell generates its own electricity due to chemical reactions taking place inside the cell, e.g. a dry cell. 159–160
PROTEIN Substance constructed from many amino-acids, e.g. Keratin. It is body-building material. An essential nutrient. 62, 146, 199, 201
PROTOPLASM The material of which all living matter is made. 12
PUBERTY The age at which one reaches sexual maturity.
PUS Material which is developed in the body at the site of a fight between bacteria and white blood corpuscles. It is made of dead bacteria, dead white corpuscles and destroyed cells. 224, 227, 228, 233, 237
PUSTULE A blister filled with pus. 219, 220, 227

QUARTERNARY AMMONIUM COMPOUNDS Sterilizing agents. 126, 239
QUICKLIME Calcium oxide—used in chemical pads for generating heat when in contact with water. 121, 149

RADIATION The way in which heat travels through space. 84
REAGENT Any substance used in detecting, measuring or examining any other substances.
RECTUM The last section of the intestine, ending at the anus. 19, 20
RED CORPUSCLES Cells in the blood which contain haemoglobin.
REDUCING AGENT A chemical that adds hydrogen or removes oxygen from a compound, e.g. Sodium sulphite. 147, 149
REFLEX A response which always immediately follows a certain stimulus (e.g. a finger is pulled away when it touches something hot).
RESISTANT (to something) Able to keep something out. 2
RETRACT (to) To draw back; to shrink back. 39
RINGWORM A skin disease caused by a fungus. It may occur on the head or body. 217ff.

SALT The result of a neutralization between acid and base (or alkali). Acid + base (alkali) = salt + water. 113, 121

SCABIES A disease caused by the itch mite which burrows in the skin of the human body. 222

SCALP The epicranial aponeurosis and the skin which covers it. 37ff., 217ff.

SEAL WATER, Water remaining in a specially designed bend in a waste- or soil-pipe. This water prevents odours from the drains entering the room. 6

SEBACEOUS GLAND A gland opening into a hair follicle which secretes a fatty substance (sebum). It develops from the epidermis but grows downwards into the dermis. 4, 47, 50, 56ff.

SECONDARY CELL (Physics) A cell which stores electricity in a chemical form. An example is the accumulator. 164

SENSATIONS Any messages coming from outside the body, e.g. changes in temperature or pressure. 30, 31

SECRETE (to) When a cell makes a substance inside itself and then exports (pushes out) the substance, it is said to secrete the substance, e.g. a sebaceous gland cell secretes sebum.

SECRETION The substance made by a gland cell and exported (pushed out) by it.

SERRATED Notched like the edge of a saw. 54

SHELLAC A substance made from resin (a hard, sticky substance insoluble in water) and used as a varnish. 145, 243

SKELETON The firm framework of the body. It is made of bone and cartilage. 12ff.

SKIN The outer covering of the body. 25, 26, 32, 35, 42ff.

SKULL The bony framework of the head. 14, 35ff.

SOAP A detergent substance grouped as (a) hard soap—made from animal fats and caustic soda. (b) Soft soap—made from vegetable oils and caustic potash. 137–138

SOIL PIPE The pipe which takes waste from a lavatory pan to the drain. 8

SOLUTE/SOLVENT A solute is the substance which dissolves in another substance called the solvent to produce a solution, e.g. salt (solute) in water (solvent) = salt solution. 134

SOLUTION A solute dissolved in a solvent. The solute may be recovered by evaporating off the solvent. 134

SPECIFIC GRAVITY The density of a substance relative to the density of a same volume of water. 70

SPHENOID BONES The bones of the temples (in front of the temporal

bones). These bones are really two wings of a bone in the underneath part of the skull. 36

SPINAL COLUMN Backbone; vertebral column. 13, 14

SPINE Vertebral column; backbone. 13, 14

SPORE A very small (usually microscopic) reproductive body which is produced by a fungus or a bacterium. Spores of fungi are generally distributed in great numbers by wind or water. Spores of bacteria are usually thick-walled and nest during dry conditions in dust or soil until more favourable conditions cause them to germinate. 217, 223, 224

STAPHYLOCOCCUS A round-shaped bacterium which is found in clusters. It is a pathogen. 226, 227

STERILIZE (to) To destroy completely all living organisms in the object or material to be sterilized. 238

STIMULUS Any change in the surroundings of a living organism which is strong enough to cause it to change its activity.

STOMACH A wide part of the digestive tract following the food-tube. It has strong, muscular walls which churn food and which secret digestive juices. 17ff.

S-TRAP An S-shaped bend in a waste- or soil-pipe in which lie 2–3 in. of water, forming a seal. 5

STRATUM GERMINATIVUM The active, growing layer of cells in the epidermis; the germinating layer. 48

STREPTOCOCCUS A round-shaped bacterium which is a pathogen. Streptococci are seen arranged in chains like necklaces. 226

STRUCTURE A supporting framework; the plan on which an organism grows.

STYPTIC An agent which retards the flow of blood by contracting the blood capillaries, e.g. Alum.

SUBCUTANEOUS Under (or beneath) the skin. 48

SUBSTANCE Any particular kind of matter. Stuff of which something is made.

SULPHONATED OILS Vegetable oils used in soapless shampoos. 140

SUPPLE Pliable; easily bent; flexible. 43

SUTURE A line of joining. An example is the junction between two of the bones of the skull. 36

SWEAT A secretion of certain glands in the skin (sweat glands). It is a slightly salty liquid. 22, 25, 34, 44, 45, 48, 49, 50, 64, 200, 203, 208, 209

SYMPTOM A change in the body which a patient feels and which indicates disease.

TELOGEN A state of resting in the growth cycle of a hair follicle. 61

TEMPORAL BONES The bones above and around the ears. 36
TENDON A band of connective tissue which attaches a muscle to a bone. It is not elastic. It can also occur as a thin sheet of connective tissue in which case it is called an aponeurosis. 15, 37ff.
TEPID Lukewarm.
TERMINAL HAIR The long, strong hair on head and body. 52, 63
THERM A therm is a unit of heat equal to 100,000 British Thermal Units. 73
THERMOSTAT A device for regulating temperatures at a set value. 79
THYROID GLAND A gland at the base of the neck which controls the speed at which the cells of the body do their work. 202
TISSUE An area in a living body of cells of the same kind and carrying on the same kind of work (e.g. muscle tissue). 12
TOXIN Poison. 219, 223, 224
TRACHEA The windpipe or air tube in the human body. It leads from the throat to the chest where it divides into two tubes, one of which goes to each lung. 17, 18
TRAGACANTH A plant gum used as a thickener and as an emulsifier. 144
TRANSLUCENT Allowing some light through but not transparent.
TRAP A place in a waste pipe where grease, hair and other solids can be removed when they accumulate. 6

ULTRA-VIOLET RAYS Rays from the sun (or made artificially by a mercury-vapour lamp) which can destroy disease organisms. They can cause the body to develop Vitamin D. 89, 240
URETERS Tubes leading, one from each kidney, to the bladder. 17
UNIT One individual thing or person, separate and complete.
UNSYSTEMATIC Not according to any plan.
URINE A yellowish fluid containing waste matter taken from the blood by the kidneys and sent, by way of the ureters, to the bladder where it is stored until discharged from the body. 19, 25, 200

VASELINE A pale yellow, grease-like substance made from petroleum. 124
VEGETABLE DYES Compounds of henna, camomile, etc., which are used as dyes or rinses. 152
VEGETABLE OILS A vegetable oil is one extracted from plants. These oils are used a great deal in toilet soaps and cosmetics, e.g. olive oil, almond oil, etc. 125
VEIN A blood vessel which carries blood to the heart. 20, 28, 49
VELLUS HAIR Fine, downy hair.

VENTILATION The entry of fresh air to replace stale air in a room without causing draughts. 90, 97, 99ff., 211ff.
VENTRICLES The two lower chambers of the heart. They have strong, muscular walls to pump out the blood. 27, 28
VERTEBRAL COLUMN The spine or backbone. It is a chain of 33 small bones called vertebrae. 13, 14
VERTEBRAE The 33 small bones which make up the backbone. 13, 14
VIROLOGIST One who studies viruses. 223, 229
VIRUSES Living organisms which cause disease in plants and animals. They are too small to be seen under an ordinary microscope and they can only multiply inside a living cell. 222, 223
VITAMINS Substances which are essential to life for the body, although they are only needed in very small quantities. The body obtains vitamins from its food. 62, 199, 202
VOLT A volt is a measurement of electrical pressure. 176–177
VOMIT (to) To throw out partly digested food material from the stomach through the mouth. 246, 247

WART A small lump on the surface of the body, most often seen on hands and face, caused by the action of a virus in the skin. 230
WASHING SODA This is a soda called sodium carbonate. A perfumed variety of the salt is called bath salts. 123
WASTE PIPE A pipe which carries used water away from hand basins, sinks and baths to the drains. 5
WATT This is unit of electricity
volts × amps = watts
1000 watts = 1 kilwatt (1 kilowatt hour = 1 unit of electricity). 179
WAVE, MARCEL Resembles a natural wave but is produced by means of heated irons.
WETTING AGENT This is a chemical substance which will break down and reduce surface tension of liquids such as water, for example detergents are wetting agents. 129
WITCH HAZEL An astringent extract from a plant; used in after-shave lotions, etc. 135